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Engine Frame and Cylinder Tools—III.

By Herman Landro.

AT THE BULLOCK SHOPS, CHICAGO, ILL.

The Willans-Robinson steam engine is more or less familiar to readers of the AMERICAN MACHINIST, having been illustrated and described in its issue of October 26, 1893, and, as is also well known, it is built under the Willans and Robinson patents, by the M. C. Bullock Manufacturing Co., Chicago, Ill. The Willans-Robinson inventions show great boldness as well as great originality of thought, and in carrying out their ideas Willans and Robinson make some very curious parts, arrangements and associations; such as putting the valve-driving eccentric in the middle of the crank wrist, and placing the steam distributing valve in the center of the piston rod. All of Willans' and Robinson's efforts were in the direction of simple and easily produced parts, capable, however, of handling very high-pressure steam in the most approved manner, and meeting the demand for very high speed engines caused by the increasing use of the dynamo. The result is a very simple piece of mechanism which can use steam in any desired manner in combinations of single-acting cylinders, having a short stroke, with the steam-distributing valve in the middle of the hollow piston rod, and which can be produced wholly in the lathe and boring mill.

Fig. 1 is from a photograph of the last engine built by Bullock, and represents the latest form of this type of steam engine, "3-P, heavy duty" type. Fig. 2 is a small scale section of another engine of what is named in the Bullock shops the "2-P" type. The "3-P" is triple expansion, the "2-P" double expansion, or ordinary compound.

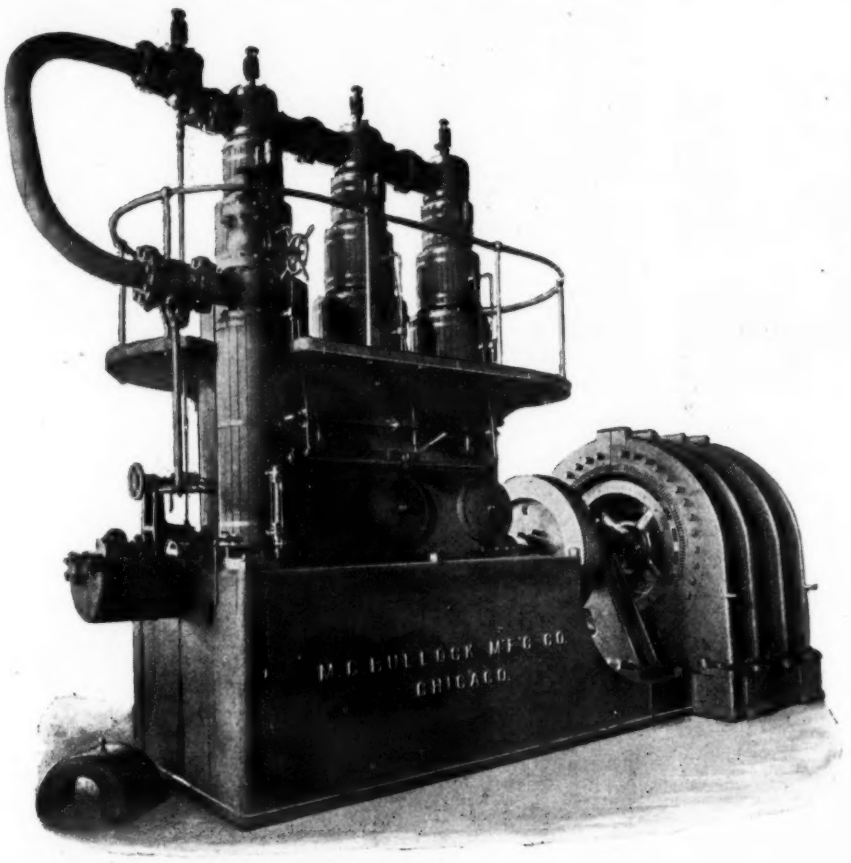


Fig. 1.

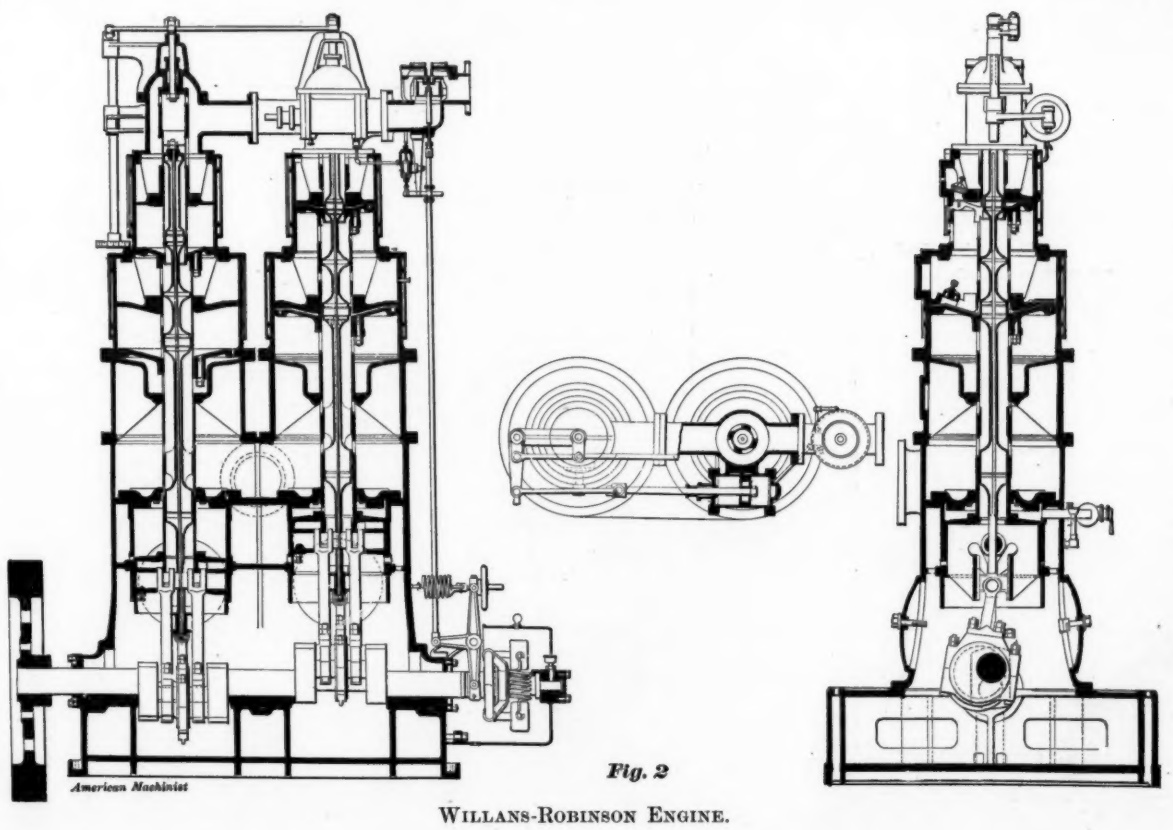


Fig. 2

WILLANS-ROBINSON ENGINE.

The peculiarity of these engines, from a machine shop point of view, comes from the peculiar Willans-Robinson construction, which involves a central piston valve working in a hollow piston rod, the piston rod having the steam ports in its cylindrical walls. This construction calls for nothing but lathe work, and at the same time calls for lathe work very little short of absolutely perfect truth. It also calls for long, straight holes of precisely uniform diameter, and because of these constructions the whole business of building the Willans-Robinson steam engine comes down, at last, to the designing of such tools as shall produce perfect external and internal cylindrical surfaces. The external cylinder can be very readily and certainly produced by the engine lathe, followed by the grinding machine; the internal cylinder is altogether another affair, and must be produced by cutting rather than grinding effects, so that at the end, Willans and Robinson found themselves forced to produce reamers which would make straight holes with certainty, and it is these reamers which constitute the sole unusual features of the Bullock tools. The straight holes in these engines are, some of them, many diameters in length, and some of them much less than one diameter long. It is therefore evident that the whole ground of reaming holes in gray iron had to be covered, and as their exhaustive study and experiments resulted in the production of forms of reamers new, so far as now known, to American practice, they are given in full herewith, and form a most interesting study. The results gained by the use of this Willans-Robinson reamer are almost absolutely perfect; indeed nothing less than a very close approximation to uniformity would serve at all. All machinists are perfectly aware of the difficulty of producing straight holes by any process whatever; generally speaking, straight holes must be produced by grinding, and very often internal grinding is a very slow and expensive process. Reaming with reamers, whether of the fluted or rosebit type, is commonly expected to make slightly tapering holes, so that a drawing for a reamed hole often has the end marked at which the reamer is to be entered, as that entering end of the hole is expected to be larger than the finishing end, where the reamer leaves the hole. Many machinists of experience believe that no solid reamer can possibly make "parallel" holes, that is, holes of uniform diameter, and hence having "parallel sides," in shop terms. It is well known that to produce holes of constant diameter by reaming, the reamer must be adjustable; must have its teeth so constructed that the reamer diameter can be increased at will. In some forms of construction this increase of reamer diameter is unlimited; in other forms, where the increase in diameter is gained by springing or bending the tempered steel reamer teeth outward, by the action of a wedge or cone, the variation can only be slight; but in all cases the reamer teeth must be set out to make up for wear, if the holes produced are to be of precisely constant diameter. It is true that solid fluted reamers can be, and are, made very slightly larger at the point, and that solid reamers of this tapering form will produce many hundreds of short holes with very small change of diameter. But when the holes are long the teeth of the reamers must be inserted, or otherwise made capable of expansion; and also when the reamer is large in diameter the teeth must be inserted, as no tool maker would be likely to advise the making of solid tool steel reamers much over 6 inches in diameter, and it is probably better to insert reamer teeth in soft bodies at diameters much below 6 inches, in most cases.

It is the Willans-Robinson practice to bore and ream their comparatively extremely short cylinders on the face plate of a common engine lathe, and this brings the Bullock shops' reaming up to diameters very far beyond the ordinary machine shop use of tools of that class.

Fig. 3 shows a Willans-Robinson cylinder being finished upon a common engine lathe in the Bullock shops; the cylinder has a head cast in it at the face plate end, but this head has a hole through it large enough to take a boring bar of sufficient diameter to carry a boring head for finishing the bore. The boring bar is not used, however; the cylinder is chucked on the face plate of the lathe and bored with a tool in the lathe tool post very nearly to size in its largest place, which should be at its outer end. In Fig. 3 the cylinder is shown when this lathe tool

boring is complete; and the reamer with which the cylinder is to be finished is shown, hoisted in the sling, ready to be

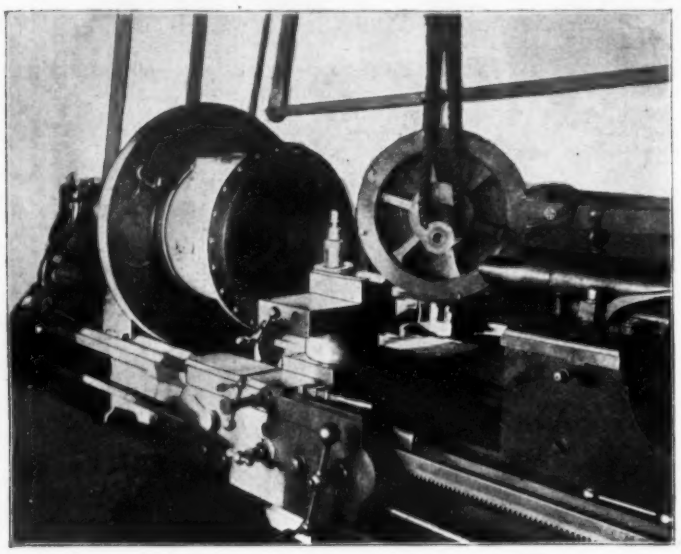


Fig. 3.

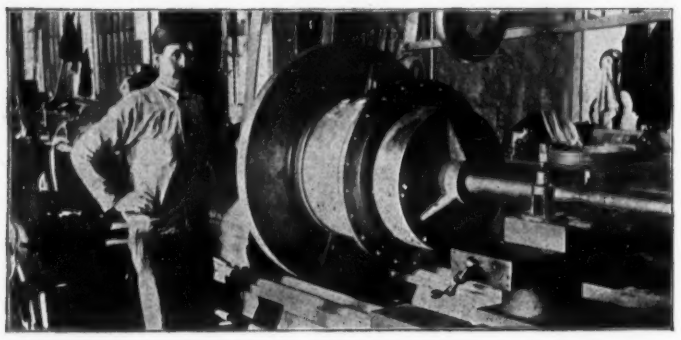


Fig. 4.

placed as in Fig. 4, where it is shown ready to begin the finishing reamer cut. The round bar shank of the huge tool is centered on the tail center of the lathe, and dogged to prevent turning, and the entering end is left entirely free, all just the same as if the reamer was of an ordinary diameter of, say, 2 or 3 inches. This reamer is made of a gray iron body, with six little cuts in it, no more and no less; three of these cuts are made 45 degrees apart, then 90 degrees to the next group of three, separated by 45 degrees as before, and then a blank of 90 degrees which reaches to the center of the first inserted tool. There are thus two groups of inserted tools, three tools in each group, 45° C. to C, then 90 degrees blank. Of this group of three inserted tools on opposite quarters of the circle in the large cylinder reamer shown in Figs. 3 and 4, only the middle tool of each group is a cutter; the outside tools of each set of three are only bearers, ground cylindrically to the exact diameter of the finished work; the four bearers in a reamer are put in straight; that is, seated in cuts parallel to the axis of the cylinder; the two cutters, however, are put in at an angle of 10 or 15 degrees to the axis of the cylinder, the lip of the cutter leading as the cylinder revolves. The cutting or entering end of the cutter is either beveled or rounded off, and the cutter is cleared in front, and on the whole of its top length; and its cutting lip is, of necessity, set a little in advance of the bearers. The novelty of this form of reamer lies in the grouping of the tools in the opposite arcs of 90 degrees each, and in the use of two cutters, each between two bearers. The whole thing is a reminiscence, seemingly of

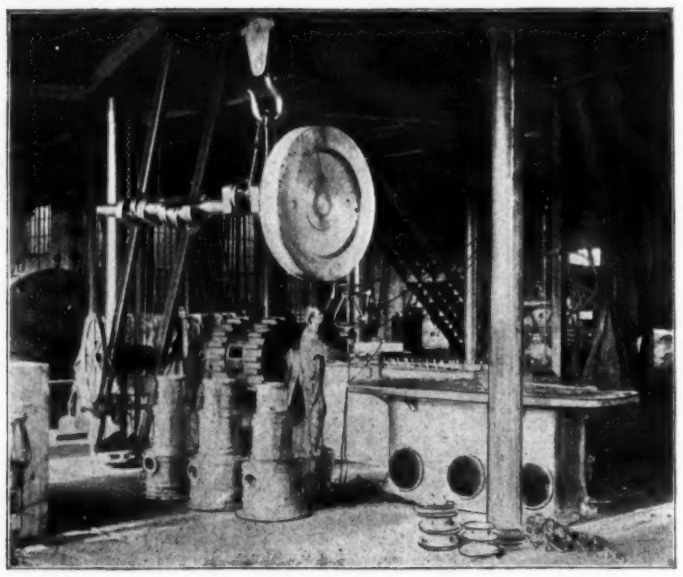


Fig. 6.

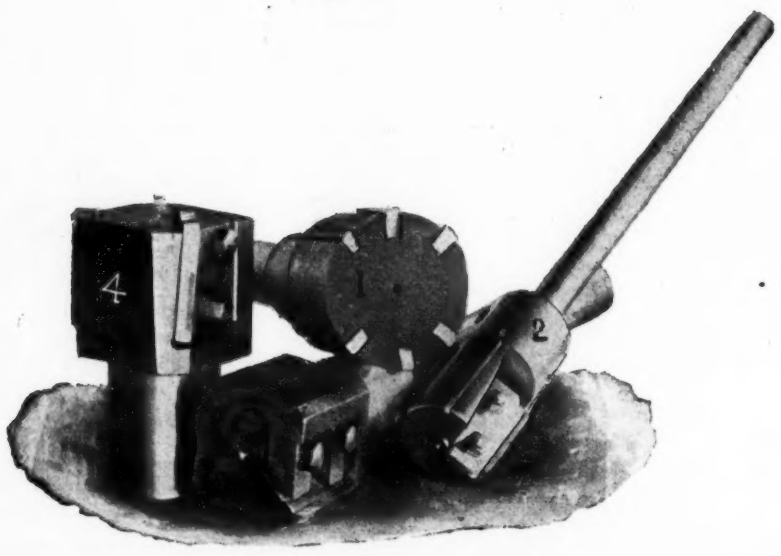


Fig. 5.

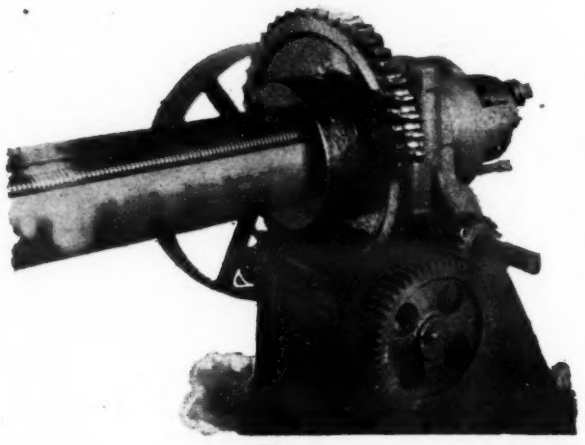
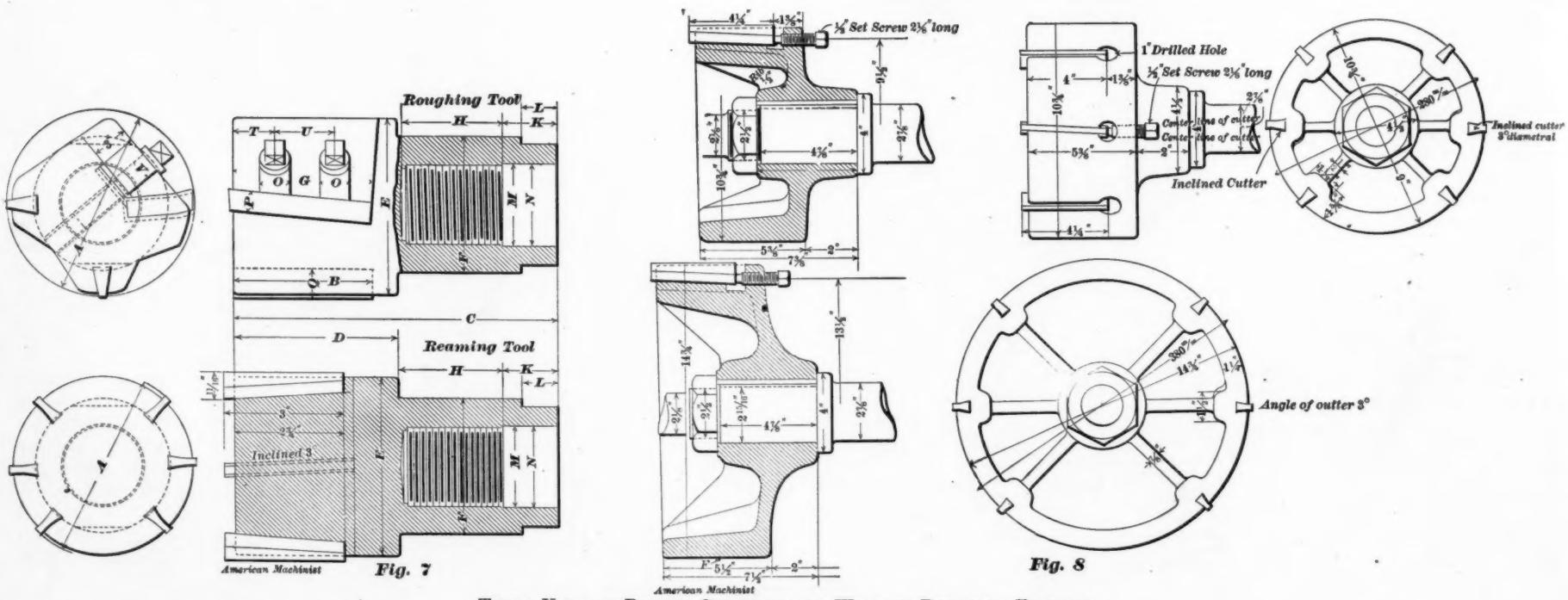


Fig. 9.



Tools Used in Boring Cylinders of Willans-Robinson Engines.

haps the very cheapest of any known form of inserted tooth reamer, adjustable for size, and durable. These are merits enough to make them worthy of a place in the old "wood drill," or flat drill with a piece of wood fastened on each side, which held so high a place in the esteem of machinists of the last generation as a producer of perfect holes. The precise office of the 90 degrees of blank space is not evident, and no explanation of its effect was given. It was said that this grouping of tools was important, and that an equal spacing of the cutters and bearers did not make so good holes as the grouping with 90 degrees of blank reamer circumference between the groups. It was further stated that these Willans-Robinson reamers were the outcome of long and expensive and discouraging experiments, and that with the grouping of tools adopted the results were invariably correct. Such being accepted as the case, this tool forms a very valuable addition to the well-known forms of reamers. It is very cheaply constructed, and can be made in any shop. The information was given by Mr. M. C. Bullock personally, who is too good and too experienced a mechanic to make statements outside of the facts. The reamers are simply straight copies of Willans-Robinson practice, nothing having been changed at the Bullock shops.

Fig. 5 shows a group of Willans-Robinson reamers of small diameter; No. 1 has six inserted tools in two 90-degree groups, same as the cylinder reamer; 2, 3 and 4 were all made with one cutter, and three bearers at 90 degrees from each other in the first instance, and have all been changed by grinding the first bearer in advance of the cutter low, so that it is of no effect at all. This brings all the bearers and the cutter into 180 degrees of the circle, leaving 180 degrees blank; the cutter leads in point of rotation and lengthwise advance both, and the 180 degrees of reamer surface in advance of the cutting lip is blank.

This is distinctly in the line of the old "cannon drill" or "half rosebit," which is another of the old timers' tools, and still in use in many places with very satisfactory results. In all cases the bearers are hardened and ground, and in all cases they are secured in the reamer bodies by dovetailing. The cutters are secured by dovetailing in the large reamers; in the smaller ones they are bolted in with caps, or screwed directly to the wall of a deep radial cut, as shown in Fig. 5. In all cases also these reamers are given only extremely small cuts to make; the work is bored very nearly to finished size before the reamer is brought into use.

Exactly why these tools make straight holes where fluted reamers of ordinary construction would not be certain to do so, cannot be told at present writing. It is quite enough to know that they can be fully relied upon to produce perfectly satisfactory work for any purpose; that they are per

the memory and note book of every good machinist.

In Fig. 6, a set of three triple-expansion cylinders is shown in the foreground with the frame on which they are finally to be mounted, and the three throw crank shaft with the solid eccentrics in the middle of the wrists, is shown in the sling overhead. This shaft is taken out of a solid forging, eccentrics and all, and calls for a master workman on the lathe, as practical machinists will probably admit. The one shown was beautifully finished, and said to be a very accurate piece of work.

In the Bullock shops there is one cylinder boring rig, having a large T-slotted table only a little raised above the floor, and a boring bar provided with traversing boring heads of different diameters, and mounted in loose housings, which can be bolted down anywhere on the boring table. Fig. 7 shows what are called the trunk boring tools for heavy duty engines, and Fig. 8 the 280 mm. (10¾ inches) and 380 mm. (14¾ inches) reaming heads as made by the M. C. Bullock Mfg. Co.

Fig. 9 shows the very neat and compact worm drive of this bar at the "live" housing end, and other worm-driven bars will be shown in these papers.

Early Engineering Reminiscences—II.

By George Escol Sellers.

When Jacob Perkins and my father established their fire engine shops, to which I have referred in the early portion of these reminiscences, they made a large number of what they called "garden engines." At that time Philadelphia received her supply of water from the little basin reservoir in the dome of the Centre Square Water-works, where the great public buildings now stand. The water was delivered through wooden logs, and consequently very little hydrant head was obtainable until the building of the reservoir at Fairmount, with its pumping engines and system of iron conduit pipes. Thus, there was quite a demand for these little garden engines. The force pump was fixed in a deep oval cedar tub hung on two wheels with barrow handles and legs like a common handcart. The force pump was the Perkins single-chamber pump, in which the hollow plunger or piston rod was exactly half the area of the pump chamber, and at its lower end was a piston with clap valve to fit the pump chamber. On the upward stroke the entire chamber would be filled with water; on the down stroke one-half this water would be ejected, the other half, through the clap valves in the piston, would fill the space in the chamber around the plunger, to be ejected through holes at the top of the pump chamber into the space made by a hanging partition in the surrounding air vessel. This partition was let into a groove and soldered to the top plate, and did not extend quite down to the lower plate. This partition and the outer air vessel were of sheet copper; the pump chamber and plunger were of drawn copper tubing. This was proposed by Mr. Perkins as being less expensive than boring and turning. The bottom bed plate carried the suction valve; it and the top plate had grooves to receive the pump chamber and air vessel, the joints being made by a few strands of white-leaded lampwick, or leather strips in the grooves, the top and bottom plates being drawn together by rod bolts outside of the air vessel.

These cylinders were drawn or rather forced through the die on one of Perkins' curious jim-cracks, a toggle-joint press. His draw bench consisted of a pair of heavy timbers bolted to the floor; they were spaced several inches apart, and held firmly by bolts passing through parting blocks. Near one end of the timbers were bolted blocks for the die to rest against, the pressure bearing on the end grain of the blocks. Another block the proper distance away, crossed and was bolted to both timbers; to this second block one leaf of a toggle joint was hinged, and the opposite end of the opposing leaf was hinged to an iron sliding carriage which crossed from timber to timber, its ends sliding in wooden grooves; this leaf of the toggle had rising from it a socket to receive a handspike or lever at such an angle that by a pumping motion a man could work the toggle. The tube to be drawn on its mandrel being well lubricated, or, as the men called it, "slushed," was placed against the die, supported in position by wooden fixtures; a heavy metal wedge, suspended just sufficiently counterbalanced to hold it in an upright position, would, as the carriage was drawn back by lifting the toggle, drop and fill the space; this it would continue to do at each stroke until the utmost thickness of the wedge was reached. The man in attendance then hoisted it back, and a square block of wood with a handle like a mallet was made to take its place and the wedge would again act. When again raised, a longer block would take the place of the first one, and so on. In drawing the plunger tubes, one man worked the lever, while two men manipulated it in making the larger pump chambers.

Commodore B——, of the U. S. Navy, was a frequent visitor to the shops, and was much interested in watching the operation of the toggle draw bench, and he would expatiate freely on the wonderful multiplication of power obtained by the toggle. (?) It was evident that something mighty was working in the Commodore's mind, the outcome of which was a great invention. One day he came hurriedly into my father's office and insisted on having father accompany him to the navy yard to see his application of the toggle to the capstan to heave the anchor. He said that with the common horizontal capstan only so much force as can handle the handspikes can be applied, but by his arrangement all the ship's crew, including the marines, could be made effective, and that with the multiplied power of the toggle there could be hardly a limit to the weight of chain cable and anchor. He refused to explain his arrangement, but was willing to show it working, as he had a complete working model. He had a carriage at the door, and hoped my father would take the time to go with him. Turning to me, he said: "Boy, you may go along, but you must not speak to anyone about what you see, for I am thinking of patenting the invention and certainly shall if your father approves, which he cannot help doing when he sees what great advantages I have gained." We were shown into a second story of a carpenter shop at the Navy Yard, where we saw a small horizontal capstan, a second-hand one from some small craft of that period. On one end, close to the handspike sockets, was a ratchet band or wheel; above this, in a horizontal position, was a long leaf toggle, one end resting against a fixed abutment, while the other joined the end of a bent lever. This lever was arranged with two sockets close to its fulcrum pin, and when the handspike was in one of these sockets it could be worked as a bent lever; when in the other, as a straight, upright lever. The Commodore explained that to show the operation of his machine he would use the bent or "pump handle," as he called it. He then threw off a cloth lying over the center of his toggle and said: "You see this hook from the center joint that clutches in the ratchet, and as it rises turns the capstan." He began pumping and turning the empty capstan, talking all the time, which my father did not interrupt, and he went on: "Now, you see, when I put my lever in the upper socket, if I have a line from the upper end I can have any number of men pulling it backwards and forwards by having a ratchet and toggle at each end of the capstan; by regular drilling the men will be taught to work on the word in perfect harmony, and the chain will be steadily and continuously hauled in." My father did not speak until the Commodore got through; he then quietly remarked, "I am afraid, Commodore, that you are applying your force at a wrong part of the toggle, or to the wrong end of the lever; suppose your toggle drops to a straight line, what force applied to it could raise your hook?" "You haven't got me there," said the Commodore, laughing; "don't you see, I have stops to prevent that. There is nothing like practical demonstration. I have tried and found by actual experiment the exact position of the motion of the center joint of the toggle that has the most powerful effect on the hook, and I have arranged to take advantage of it." Father looked worried. He knew that the Commodore had built greatly on his favorable opinion, and he was thinking how he could open his eyes to his mistake with the least embarrassment. Father took up the end of a line that was lying near and said: "I see there is a hole in the floor; suppose you fasten this line to the capstan and let the other end down to the room below, and with something like a scale disk by weighting it, test the amount you can raise." While saying this, father was fastening the rope to the capstan. There was one workman in the room, presumably the man who had put up the machine, for he seemed to have charge of it. Father continued: "Let this man go down and take hold of the rope; do you think you could haul him up?" "Yes, yes," said the Commodore, "and a dozen more like him. Don't you see the leverage I have multiplied by the toggle?" He laughed heartily at the idea of testing his power by the weight of one man. As the man went down, father privately instructed him to pull gently hand over hand and allow a few turns of the capstan to be made, then when he heard a signal knock on the floor, to throw his entire weight on. The instructions were so well followed that the Commodore's strength was tried for a minute or two, and when the knock was given, he threw himself across the lever, struggling hard to thrust it down, but was finally lifted off his feet, and losing his balance and his hold on the lever, he fell heavily to a seat on the floor, exclaiming, "What trick is this? I shall investigate and someone will suffer." Father only remarked that "practical demonstrations were mostly to be relied upon." Seeing the utter discomfiture of the Commodore, my father took a good deal of pains to make him understand the action of a toggle. I recollect his using a common jointed carpenter's rule laid flat on a bench, the end of one leaf against a stop, one hand at the middle joint, the other at the end of the other leaf, and the Commodore was directed to try the strength of one hand against the other, a simple illustration by feeling, and from his looks, I think the Commodore was satisfied. I was cautioned against ever referring to a toggle in the Commodore's presence, and it was a long time before he again visited the shop. He then brought with him the model of a ship pump to throw volumes of water in case of leakage. It was simply an enlarged beer pump such as was then in common use in England, or a section of the old "Roundtree" fire engine pump, but as the Commodore was not acquainted with either of these, it was with him an original invention, certainly a good pump if worked under water or liberally primed, and a good hobby for the old gentleman's amusement.

I know nothing of the early schooling of Commodore B——, and I have only related his toggle joint exploit in evidence of deficiency in the early schooling of a century ago, when a boy could be admitted into the naval service and rise to the position of commodore without a knowledge of the simplest mechanical principles. With our present naval school such a thing could not happen, or even with a common-school education, for since the advent of normal training and technical schools, mechanical philosophy has gained a strong footing in them, and every pupil now has the opportunity of obtaining that kind of knowledge, which was not deemed important by our forefathers at the period referred to.

On the occasion of one of Mr. Paddock's visits to me there was lying on my table an issue of the American Machinist of January 3, 1895, which he opened at an illustration of an improvement in a friction lift drop hammer with a reference to a full illustration in the number of October 4, 1894. This led to a discussion on the slow progress in the use of drop forgings, and what led me to design what I think may justly be claimed as the first friction lift hammer. I know the difficulty of tracing early inventions to their origination. Being at a loss for the dates of some other early matters we were discussing, I opened a case of old drawings that had not been looked into for many years, and the first paper I unrolled proved to be the specification and drawings of a patent issued to me for a friction lift hammer, on the 10th day of January, 1845, exactly half a century before the day of our discussion, which was the 10th day of January, 1895. Among a number of hammer drawings I found two especially for drop forgings, one dated December 9, 1846, the other January 14, 1847, which I think it would be well to reproduce. In my reminiscences I have endeavored to make the description so clear as not to require illustrations, but in this case it would be a fair comparison with the machines now in use as to essential points. Some notes of what led to and induced me to make the invention may be interesting to inventive mechanics. When in Birmingham, Eng., in 1832, I visited two establishments that were using drop presses, one was a manufactory of battered ware and sportsmen's equipments. The "battered ware" consisted of pans, kettles, etc., of brass, beat into form under light trip hammers, and the ware being light and shipped in nests, was in great demand in America by the Indian traders and emigrant outfitters. The second belonged to a manufacturing gunsmith. Portions of gun locks and some stock trimmings were forged in dies by the drop press, as it was then called. It was a very primitive concern. Immediately back of the hammer block was a pair of parallel endless chains about three inches apart; at a distance of about a foot they were joined by an iron bolt, making of them a moving ladder. When the operator wanted his hammer raised he would draw towards him a lever that hung in front of the hammer, hooking the upper end of it on one of the ascending ladder steps. An adjustable bar fixed at the hight the hammer was to raise, pushed back the lever, disengaged the hook, and allowed the hammer to fall. The work done on the copper powder flasks and on sheet brass ornaments for the hardware trade was beautiful and artistic.

My visit to England was immediately after the death of Sir Walter Scott, when all the theaters and places of interest were exhibiting pageants of his characters and other devices in commemoration of the distinguished author. Jennings & Chaplin, of Cheapside, advertised a bronze medal with the head of Scott, from Chantrey's bust, with a reverse designed by R. Stothard, R. A.; the dies engraved by A. I. Stothard, die maker of the Royal Mint. The newspapers spoke of it as the most perfect and beautiful medal ever struck. I purchased one and found it not bronze but copper. It was certainly very beautiful. It was about 2¼ inches diameter, ¼ inch thick on the rim, with the motto "*Bardorum-Citharas Patrio Qui Reddidit Istro*," in block Roman letters deeply milled in; the head was in profile high relief; the reverse was a full length female figure with pencil and scroll "to great men." On my return to Philadelphia, Adam Eckfeldt, at that time chief coiner of the U. S. Mint, asked me if I had seen the celebrated Scott medal which had been so extensively advertised. In reply I handed him the medal, which he examined with great care for a long time before he spoke, and then remarked, as if talking to himself: "This could not have been struck from a flat planchet, nor the thin raised edges and the deeply sunk motto been made by the English milling machine." Then turning to me he said, "The concavity of the reverse is not sufficient to account for the metal in the raised head under any degree of pressure, the planished surface is more the work of a roller than a die." The motto around the edge could be sunk on a straight thin strip of sheet copper, but if so, he could not discover where its ends had been joined together; still, he believed the medal was made up of thin sheet copper. I told Mr. Eckfeldt that after I had purchased the

medal I had seen in the sample room of the drop press works a Scott powder-flask, and I had remarked to the attendant that they had made an admirable copy from the Scott medal. He said, "Yes, it was struck in the original die." At the time this did not excite even a suspicion that the medal was a fraud, but to Mr. Eckfeldt it was conclusive. I suggested using a drill, for if of sheet copper the filling would probably be some white fusible metal, and the drill settled it, for it went into a cavity of near ¼ inch before reaching the metal filling. It is a specimen of the beautiful work of that period by the drop hammer; a cheap Birmingham production that sold rapidly at five shillings each.

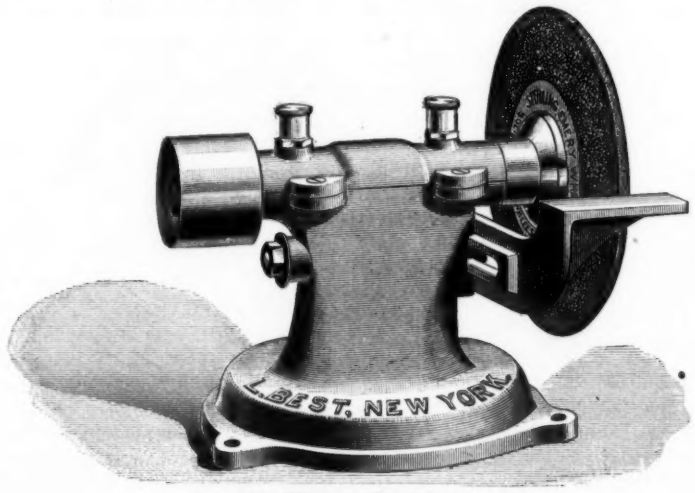
New Adjustable Calipers.

Arthur Munch, St. Paul, Minn., has devised an adjustable caliper, of which we give an illustration. The calipers are of the familiar form, the heavy central rivet being countersunk at both ends, and, by means of notches in the back countersink, being held from turning in one of the legs, the other being movable for setting. Upon the central rivet and outside the movable leg is an "adjusting bar" movable about the rivet and clamped in any position by tightening the large thumb nut covering the upper end of it, which is split. Upon the movable leg of the caliper there is pivoted a stud, in which is shouldered a milled headed adjusting screw, the threaded end of which works in a pivoted stud upon the adjusting bar. The adjusting bar being movable, as described, a short screw is sufficient for any adjustment within the range of the calipers either inside or outside.

A New Caliper.

One-Wheel Emery Grinder.

We present herewith an engraving of a grinder designed for general use in sawmills, woodworking establishments, and other places where a limited amount of grinding is to be done and the machine must be low in cost yet serviceable. Its construction will be readily understood from the engraving. The spindle bearings are 3 inches by $\frac{1}{16}$ inch; entire length of spindle 14 inches. The spindle pulley is 2½ inches diameter. It carries a wheel up to 12 inches diameter, 1½ inches face. The maker is L. Best, 45 Vesey street, New York.

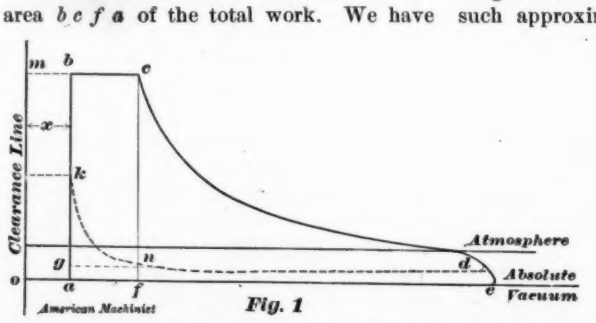


One-Wheel Grinder.

Absolute and Net Indicated Horse-Power.

By W. H. Booth.

Probably some of the younger among engineers may have come across the term absolute horse-power as applied to steam engines, and have not known just what was intended to be conveyed, yet this question of absolute power is one of exceeding importance, for by a proper understanding of it we may learn much more accurately the true behavior of steam. Here, for example, in Fig. 1 we have a diagram *a b c d e a* from an engine with a perfect vacuum, and no compression. This area represents the work done by the steam which fills the length *b c* of the cylinder, and has the volume *a b c f a*. This volume of steam is admitted into the cylinder, or, rather, it is pushed into the cylinder by the pressure in the boiler, and as a strict matter of fact, that portion of the diagram *a b c f a* represents work done in the boiler, not by the steam in the cylinder, and if there did not happen to be a fire under the boiler the admission line *b c* would not be horizontal, but would be a portion of a huge expansion curve in which all the steam in the boiler, in the pipes and in the valve chest took part. In actual practice, however, the boiler is producing steam as quickly as it is being used, and *b c* becomes a horizontal line, and it is correct to say under this assumption that so far as *b c* is really horizontal, then is the work done on the piston of the engine done directly by the fire in the boiler. However, this by the way, for it does not particularly concern what I set out to say, which is that the work done on one forward stroke is represented by the area *a b c e a*. But when we come to measure an actual diagram we find that we never do obtain a perfect vacuum, but get a figure much like that enclosed by the upper part of the diagram and the lower dotted line or by the area *b c d g b*. Now in such a diagram as this we have not varied the initial volume of steam in the cylinder, and the absolute work of the steam is still shown by the old area *b c e a b*. But on the return stroke we have a pressure acting against the piston, and the power that is represented by this pressure is the area *a g d e a*. The result of this back pressure is that less energy goes into the fly wheel, and how much less steam do we employ? The initial volume in the cylinder is the same, namely, *a b c f a*, but part of this is made up of the uncondensed steam left in the cylinder, namely, the volume *a g n f a*, and we have used a volume from the boiler *b c n g b*. But the area *g n f a* is a less ratio of the back work than is the area *b c f a* of the total work. We have therefore reduced the net effective work of the engine. For various reasons we really make the diagram take the form indicated by the curved line from *n* to *k*, and in this way we save some steam and suffer the additional back work loss, so that the back work area is now *k n d e a k*, and the net indicated power is *k b c d n k*. The sum of the two is the absolute work of the steam.



Perfect Vacuum—No Compression.

If we draw the clearance line at a distance = *x* behind the diagram to represent the proportion of clearance volume in the cylinder, then the real volume of steam admitted is *o m c f*, and in compressing the back pressure steam up to *k*, we really save one-half of the steam necessary to fill this clearance volume, while we lose, as stated, the area *n g h* of work. It is now becoming evident that if the condenser vacuum becomes still poorer, the area *a g d e* will become greater and so reduce the net, or as usually termed, the indicated horse-power. But no matter how we treat this lower half of a diagram—which is really two diagrams put together—we do not alter the fact that the steam we have admitted has done a certain duty. How we may deal with such duty is another thing. We like to set it turning the crank, but we cannot help using some of it to push the exhaust steam into an imperfect vacuum, which is what we do when we get a back pressure diagram, *a k n d e f a*. Where we do not have a condenser we have to use a good deal of the absolute work to help us to push out our exhaust steam against a full atmosphere of 15 pounds pressure, but we must not think that in a non-condensing engine the steam has done any less work than it does in a condensing engine. The steam does not know anything of what occurs during the back stroke. It does its duty on the forward stroke and has no knowledge as to whether it is pushing round the crank or simply pushing the piston against back pressure. In comparing engines and figuring on the work got from steam, it is the absolute or total work we have to measure to know what the steam has really done. Then the back pressure must be known simply that we may say if the condenser is acting well or if the exhaust port is big enough, and finally the brake horse-power should tell us the mechanical efficiency of our engine as a machine, and perhaps show where the bearings run hard or the piston is too tight a fit.

Thus the brake horse-power must be as large a fraction as possible of the indicated horse-power, and this in turn as large a fraction as possible of the absolute horse-power. If we do not take the absolute horse-power into account we are liable to make very rough calculations. Yet we often do make such approximations. Thus, for example, if we divide the foot-pounds of work done during the expansion part of the stroke by 772 we shall obtain the number of heat units converted into work, and from that may calculate the amount of steam condensed. But we must not take the net indicated horse-power in making the calculation, or we shall seriously underrate the amount of the condensation. We must take the expansion area *f c d e f* for the measure of the work done by the expanding steam, and from that we must really calculate the amount of liquefaction on which to base any figures as to superheating, etc.

An indicator really gives us two diagrams, both raised upon the line of absolute vacuum, and it is the difference of these two diagrams which gives us the net work, but must not be used to base any thermal calculations upon, or it may lead us to results too small or too great, and, moreover, comparisons so drawn will be valueless. A really good engine with a bad vacuum may show a worse result than a bad engine with a good vacuum. The goodness of the engines may be entirely a question of small interior surfaces, and these rough or polished, and yet the mere accident of a faulty condenser would condemn these good points, whereas a proper evolution derived from the absolute horse-power would have shown the value of the good design and pointed to the faulty condenser as needing attention.

London.

Reversing the Locomotive for Quick Stops.

A series of tests has recently been made at Nashville, Tenn., with the special design of ascertaining the effect of reversing the engine in connection with the use of the brake for emergency stops. Nearly 100 runs were made, occupying six whole days, and the circumstances of the trial throughout were as favorable as could be desired. The results obtained are entirely condemnatory of the practice of reversing the engine for the purpose of stopping either the engine or the train. The stop is not made as quickly and the tires are injured. "The results of these tests should determine the inadvisability of using the reverse lever in conjunction with air brakes."

It is probable that the transportation of cylinders of highly compressed gases is more extensive in England than with us, although it is rapidly increasing here also. The English railway companies generally have given notice that these cylinders will only be taken under special conditions: They must be made of wrought-iron, or of mild steel of the best quality, with not more than ½ per cent. of carbon, thoroughly annealed after manufacture, of sufficient strength and carefully tested. They must be encased in closely braided hemp or wicker work, or they may be fixed in a wooden box with rope handles. The idea seems to be to protect them from knock or sharp jar and from sunshine. Nothing is said about safety valves.

It is proposed to combine the Watervliet Arsenal, at West Troy, N. Y., where guns are made for the army, with the Naval Gun Shop at Washington, where precisely similar work is done for the navy. There may be some good reasons why such a combination should not be made, but it certainly would reduce the cost of guns if the combined establishment were to be well managed.

The Brooklyn Heights Railroad Co. has brought suit against the city of Brooklyn for damages resulting from recent ordinances limiting speed of cars to six and eight miles per hour; the claim being that about $9,000,000 were spent in improvements based upon ordinances permitting a speed of ten miles per hour.

A Screw-Cutting Puzzle.

We have received the following letter, which is not clearly and satisfactorily intelligible to us, and as we have not been able to reach the writer by mail we reproduce it here in full, hoping for future developments.

Editor American Machinist:

I was ordered to cut a screw 1½-inch pitch on a lathe that has a lead screw of four threads per inch, and was directed to connect my gearing with the small gear on the lathe cone, as the other gearing was not strong enough to cut 1-inch pitch without breaking the gearing below the lathe spindle which is used to reverse the motion of the lead screw, so it would not do to try and cut the 1½-inch pitch by the usual method of lathe gearing. The gearing on the lathe is 76, 27, 78 and 25. The 76 is on the lathe spindle, the 27 and 78 are the back gears, and the 25 is on the lathe cone. The other two working gears used in connecting with these four

gears were 41 and 60, the 60 on the lathe lead screw.

Now I did not come anywhere near cutting 1½ pitch with my arrangement of the gearing, but was informed from the office that if I would put on a gear of 54 teeth in place of the 41, and a gear of 38 teeth in place of the 60 teeth gear on the lead screw there would be no trouble, which proved to be correct. Now I am unable to figure out that the calculation which I made was not correct, nor am I able to figure out that the office calculation was correct, though it proved to be correct. Will some of the correspondents of the AMERICAN MACHINIST please help me out and show me where I am wrong as I am young at the trade?

Cincinnati. ANDREW SAYERS.

Our readers here have it as we got it, and know as much about it as we do.

We illustrated and described a device about fourteen years ago (December 17, 1881), for speeding up a lead screw for coarse pitches. The large back gear was used in that case to drive the train, giving really the same result as where the connection is made to the small cone gear as described by our present correspondent.

We are unable to make anything of the train of gears as they stand, and are under the impression that the entire train is not given. Of course intermediate gears need not be considered. The pitch of the lead screw being 4, and it being required to cut a screw of 1½-inch pitch, the lead screw should, of course, make 6 revolutions to 1 of the lathe spindle. Taking the gears that the writer says were all right we can make the computation come out correctly by adding one more gear to the train. Assuming the big gear on the main spindle to be the first driver the case would stand like this:

Spindle revolutions 1.

Drivers,	76.....	Driven gears,	27.
"	78.....	" "	25.
"	25.....	" "	x.
"	54.....	" "	38.
	Revolutions screw.....		6

Here the 25 on the cone is both a driver and a driven gear and x is a gear evidently needed to complete the train, and it must be a gear that will as a factor make the total product of its column equal that of the other column. We cancel all the factors possible in both columns like this:

2	76	27
13	78	25
	25	x
2	54	38
		6.

Then multiplying the surviving factors in the first column together the result is 52, and the missing gear in the other column should therefore be 52 to equal it.

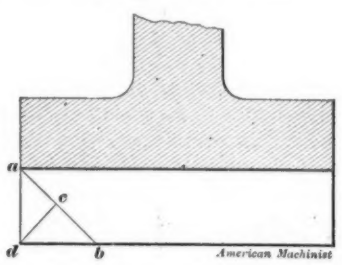
1
76.....27
78.....25
25.....52
54 38
6.

The products of these two columns will be equal, and the train will give the required speed to the lead screw.

The Horse-Power of Gear Wheels.

No one who has had occasion to consult the available data on the horse-power of gear wheels, will deny that there is a tolerably wide difference between the results of the several rules and formulæ which are to be found in the various engineering text and pocket books. Recently, as the result of half an hour's search, I obtained no fewer than twenty-three different rules, every one of which gave me a different value for the horse-power which a certain wheel could be safely entrusted to carry. Nor was the difference between the greatest and the least of these results inconsiderable, for taking the extreme values, the wheel could be considered good enough for 54 or for 150 horse-power, as might be desired.

Obviously the different values of the allowable stress on the material is one of the variables which have to be reckoned with in this connection, and as few or none of the



rules ever indicate the amount of stress imposed, it is not a matter for surprise that we have such a confused condition of things as now obtain.

But this is not all. Opinion is equally divergent as to the manner in which the load is to be taken as coming upon the teeth, some considering that the strength of a gear wheel tooth varies directly with the breadth, while others base its power-transmitting capabilities on its resistance to corner breaking. Evidently this difference of opinion only makes "confusion worse confounded," this being accentuated by the fact that no notification ever accompanies the rules as to which theory lies at their root. Another, but fortunately a very small section of rule makers, drags the "laws of impact" into the discussion and thus introduces another variable factor into the question at issue.

In endeavoring to place the subject upon a more rational basis, I found from a careful consideration of the several points involved, that it was possible to construct a table which could be employed for any allowable stress on the material, and which would apply equally well to those wheels in which the teeth may be considered as liable to break across the corner, as for those which may be taken as bearing equally throughout their width.

Considering first the case in which the load is assumed to act at one corner of the tooth, we will take as a length of tooth, $l = \frac{3}{4}$ pitch and the thickness of tooth $t =$ 0.4 pitch (to allow for the effect of wear). Further, we will make the customary assumption, that one-half of F, the driving force, is taken by each tooth, while for the stress per square inch on the material f, we will (for reasons subsequently explained) take 1,000 pounds.

In the sketch herewith, representing a tooth in plan, it can be shown that failure will occur along the line $a\,c\,b$—a line making an angle of 45 degrees with the edge of the tooth. If $x = a\,c = c\,b = c\,d$ and the load $P\,(= \frac{1}{2}\,F)$ acts at d, the bending moment is $P\,x$. The moment of resistance of the section is similarly $\frac{2\,x\,t^2\,f}{6}$, so that if $p =$ pitch,

$$P\,x = \frac{2\,x\,t^2\,f}{6} \text{ and } P = \frac{t^2\,f}{3} = 0.0533\,p^2\,f.$$

Inserting the values as above

$P = 53.33\,p^2$ pounds and $F = 106.66\,p^2$. (1)

Taking next the case in which teeth are supposed to bear uniformly throughout their entire breadth b, we have

$$P\,l = \frac{b\,t^2\,f}{6} \text{ and } P \times \tfrac{3}{4}\,p = \frac{b \times 0.16 p^2 \times f}{6},$$

so that $P = 40\,p\,b$ and $F = 80\,p\,b$.

Also since the breadth or face of the wheel is frequently expressed in terms of the pitch, we may write (if $b = k\,p$)

$$F = 80\,p^2\,k. \qquad (2)$$

Reverting now to a consideration of the *horse-power* transmitted (H. P.) we represent by D the diameter of the gear in inches; by N the number of revolutions per minute, and by F the driving force. Then we have

$$H.\,P. = \frac{F\,D\,N\,\pi}{33{,}000 \times 12} \text{ and } H.\,P. = 0.000846\,D\,N\,p^2, \qquad (3)$$

when the load falls on the corner of the tooth; and

$$H.\,P. = 0.0006346\,D\,N\,k\,p^2 \qquad (4)$$

for evenly distributed pressure upon the tooth.

Upon examination it will be seen that the constant in (4) is *three-fourths* that of the constant in (3), and this fact enables a very serviceable table to be calculated which can be readily used for cases in which corner breaking is to be allowed for, or for those in which uniform bearing of the teeth can be calculated upon. Further, by taking a stress of 1,000 pounds per square inch, as the stress on the material, it becomes an easy matter to modify the tabulated values to suit any given conditions.

From the table I have constructed and which is given herewith, the horse-power per revolution transmitted by gears of from 1 to 6 inches pitch, and from 10 inches to 15 feet in diameter, may be obtained. When the load is taken as acting so as to break the tooth across the corner, the table is to be used directly, the result giving the horse-power, when the stress on the material is 1,000 pounds per square inch, as already explained. For any other stress the tabular number found is to be increased or diminished in a corresponding ratio.

For evenly distributed tooth pressure *three-fourths* of the tabular value is to be multiplied by k, the ratio of the breadth or face of the gear to the pitch. Then for stresses other than 1,000 pounds per square inch, the result is to be increased or diminished as in the first case.

Notwithstanding some contention to the contrary it is, without doubt, very desirable to make a clear distinction between the two cases of tooth failure as above referred to. It is evident that in cast gears for rough service in crane gearing, agricultural machinery, etc., where the wheels are of only moderate width, or where the shafts cannot be maintained in strict parallelism, nor their relative positions permanently secured, corner breaking must be provided against, the breadth of the tooth being ignored in estimating its strength. On the other hand, for the best cast and for all cut gears carefully carried by shafts substantially supported, it is reasonable to assume that a fairly even bearing is obtained across the face of the tooth, and here the breadth is a factor which enters directly into the consideration of the power-transmitting capabilities of the wheel.

In either case it is obvious that in deciding upon the allowable stress due regard must be paid to the nature of the service, the conditions of operation and the character of the material.

An analysis of several examples from practice shows that for cut gears of cast-iron subjected to little shock, a stress of about 4,000 pounds per square inch is allowable. Under similar conditions steel gears might be stressed to about 7,000 pounds. If much shock or vibration is to be provided for these stresses should be reduced considerably, 2,000 pounds for cast-iron and 3,000 pounds for steel being sufficient. For high speeds these stresses should also be reduced, while for uncut gears of cast-iron from 2,800 to 1,600, and for wood 1,700 to 1,000 pounds per square inch appear reasonable values. I find that several of the more reliable tables of horse-power of cast-iron gears involve a stress of from 2,000 to 2,500 pounds per square inch, and this appears to be a reasonable range of intensity of stress for ordinary cases. With the accompanying table, however, any stress, which other than ordinary circumstances may render it advisable to adopt, may be readily substituted, and the corresponding horse-power obtained with the utmost facility. M. E.

Horse-power of Spur Gears Per Revolution Per Minute.

PITCH IN INCHES.

Diam. of Gear in ins.	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6
10	.008	.013	.019	.025	.033	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
12	.010	.015	.022	.031	.045	.051	.063	....	....	....	....	....	....	....	....	....	....	....	....	....	....
15	.012	.019	.028	.039	.050	.064	.078	.096	.114	....	....	....	....	....	....	....	....	....	....	....	....
18	.015	.023	.034	.046	.061	.075	.095	.115	.137	.161	.186	....	....	....	....	....	....	....	....	....	....
21	.017	.027	.040	.054	.071	.089	.110	.134	.160	.187	.217	.249	.284	.320	.360	.401	....	....	....	....	....
24	.020	.031	.045	.062	.081	.102	.126	.153	.182	.214	.248	.285	.325	.366	.412	.458	.505	.560	.610	.670	.730
27	.022	.035	.051	.069	.091	.115	.142	.173	.205	.241	.279	.320	.366	.412	.462	.515	.569	.630	.686	.754	.821
30	.025	.039	.057	.077	.101	.128	.158	.192	.228	.268	.310	.356	.406	.458	.514	.572	.632	.700	.762	.838	.912
33	.027	.043	.062	.085	.111	.141	.174	.211	.251	.295	.341	.392	.446	.503	.565	.630	.695	.769	.839	.922	1.00
36	.030	.047	.068	.093	.121	.154	.190	.230	.274	.322	.372	.427	.487	.550	.617	.687	.758	.839	.915	1.00	1.09
42	.035	.055	.079	.108	.142	.179	.221	.269	.319	.375	.434	.499	.569	.641	.720	.801	.885	.979	1.06	1.17	1.28
48	.040	.063	.091	.124	.162	.205	.253	.307	.365	.429	.497	.570	.650	.733	.822	.916	1.01	1 12	1.22	1 34	1.46
54	.045	.071	.102	.139	.182	.231	.284	.345	.410	.483	.558	.641	.731	.825	.925	1 03	1.13	1.26	1.37	1.51	1.64
60	.050	.079	.113	.155	.202	.256	.316	.384	.456	.536	.620	.712	.812	915	1 03	1.14	1.26	1.40	1.52	1.67	1 82
66	.055	.086	.125	.170	.223	.282	.348	.422	.502	.590	.682	.783	.894	1.01	1.13	1.25	1.39	1.54	1.68	1 84	2 02
72	.060	.094	.136	.186	.243	.308	.380	.461	.547	.643	.745	.855	975	1.10	1.23	1.37	1 51	1.68	1.83	2.01	2 19
78	.065	.102	.148	.201	.263	.333	.411	.499	593	.697	.806	.925	1.06	1.19	1.33	1 49	1 64	1.82	1.98	2 18	2 37
84	.070	.110	.159	.217	.284	.359	443	.537	639	.750	.869	.997	1 14	1.28	1.44	1 60	1 77	1.96	2.13	2.34	2.56
96	.080	.126	.182	.248	.324	.410	.506	.614	.730	.857	.993	1.14	1 30	1.46	1.64	1.83	2.02	2 22	2.44	2 68	2.92
108	.090	.142	.205	.279	.364	.462	.569	.691	.820	.965	1.11	1.28	1.46	1.65	1.85	2 06	2.28	2.52	2.74	3.02	3 29
120	.100	.157	.228	.310	.405	.513	.632	.768	.912	1.07	1.24	1 42	1 62	1.83	2.06	2 29	2 53	2.80	3.05	3.35	3.65
132	.110	.173	.250	.341	.445	.564	.695	.844	1.00	1.18	1.36	1 57	1.79	2.01	2.26	2 52	2 78	3.08	3.35	3.69	4.02
144	.120	.189	.273	.372	.485	.616	.758	.921	1 09	1.29	1.49	1.71	1.95	2.20	2 47	2 75	3 03	3 36	3.66	4 02	4.38
156	.130	.205	.296	.403	.526	.667	.821	.997	1.18	1.39	1.61	1 85	2.11	2.38	2.67	2.98	3 28	3 64	3 96	4.36	4.75
168	.140	.220	.318	.434	.567	.718	.885	1.07	1.27	1.50	1.74	1.99	2.27	2.56	2 88	3.20	3.54	3.92	4.27	4.69	5.11
180	.150	.236	.341	.465	.608	.770	.949	1.15	1.37	1.61	1.86	2.14	2 44	2 75	3.08	3.43	3.79	4.20	4.57	5.03	5.48

LETTERS FROM PRACTICAL MEN.

Ring and Chain Oilers.

Editor American Machinist:

Mr. R. D. O. Smith's second letter on the above subject inspires me to say a few words, and as the device is pretty extensively used, and generally well known, it is time perhaps that I should father what discredit there may be attached to it by admitting that I am, I suppose, responsible for the device. At least, I have not seen or heard of its use earlier than the publication of an illustration in *Engineering*, in 1868, in connection with line shaft, hangers, and couplings which I furnished. We have no trouble whatever with the rings failing to deposit the oil on the shaft, for the simple and sensible reason that we turn a couple of narrow grooves on the inside of the ring, which, of course, start up more than full of oil, and the faster the ring runs the sooner it reaches the top of the shaft, and the less time the oil has to escape. The rings are better than the chains because less gap is required in the box, and, too, for the reason that the inside can be grooved as mentioned above. JOHN E. SWEET.

Syracuse, N. Y.

The Up-to-date Limit of Elasticity in Iron.

Editor American Machinist:

I have noted a couple of remarkable statements of the elasticity of iron or steel, in recent issues of the AMERICAN MACHINIST. The first to attract my attention appeared upon the editorial page, July 18th, wherein Mr. B. F. Isherwood, chief engineer of the U. S. Navy told how, many years ago, the sheets of a boiler just unbuttoned themselves from the rivets without mutilating the holes in the sheets or the heads of the rivets. And now, August 8th, Mr. A. S. Richardson tells how water got into the cylinder of an engine, and caused the head to spring away *at least an eighth of an inch* at every

revolution, and was just as tight as a drum afterwards.

I cannot repress the thought that in these two statements the properties embodied in them might have been differently distributed with beneficial results. A little less elasticity in the material, and a little more of it in the statements would have made them more easily credible. Tecumseh Swift.

Those Wire Calipers.

Editor American Machinist:

I have read with interest all of the items on calipers, and thought we were going to get a rest, when "A. K. A." said, "It depends on the man on the end of the calipers." I think so, too.

A mechanic writes that he "uses the micrometer." I wonder if he realizes that no two men can gage their work *just* alike. Are we not falling into the same error, *i. e.*, "weighing our work," just the same as when we used the calipers, by shoving the micrometer over our work, by the sense of feeling or touch? Now, the only way out of this is an indicator on the micrometer, then one man can make his work absolutely like another one's work. And with an indicator on his calipers can make the work absolutely with the micrometer.

As micrometers and calipers are made to-day, one is little better than the other, except in looks and price. Neither of them gets out work absolutely.

I have had men bring me a micrometer "set right," and I have found, according to my sense of touch, that they were from three to ten one-thousandths smaller than I should have set them. So in order to get the work out as they thought, and "felt right," I have been obliged to set the micrometer to my sense of touch, and the work was pronounced "right," according to their view.

Now, to come down to the facts of the case, those calipers that mechanic wants to "send to Africa, to be used as nose rings," have their place and use.

They were originated at the shops of the Lamb Knitting Machine Co., of Chicopee Falls, Mass. There is a place on their knitting machines where no other kind of calipers can be used, and they were coiled, flattened, bent, and on the first pair another wire was twisted around the legs in order to close them.

Mr. T. C. Page, superintendent of the works, saw them, proposed to Mr. Geo. Hadley, who invented them, to patent them, and they were sold to the Stevens Rifle and Tool Co., by whom they are now manufactured. As to lightness and sensitiveness of touch, they cannot be beaten.

I use them on work from 2½ inches down, and by the micrometer, as I set it, find that I come as near as one and a half one-thousandths of the size that I want, roughing, and I have duplicated many pieces of work with them. Old-Style Mechanic.

The Safety Valve on the Monkey Wrench.

Editor American Machinist:

I am not sure that anything need be added to the communication of "Superannuated," on the influence of the screwing-up stress upon the strength of bolts. I feel impelled, however, to offer a few illustrations which have often been made to do service before, in somewhat different dress.

Referring to Fig. 1, it will be seen that screwing up the nut compresses the spring interposed between *A* and *B*, and we will assume that the load put upon the bolt by this operation is 4,000 pounds. It will appear that the compression of the spring is very great compared with the accompanying extension of the bolt. Now, neglecting the slight extension of the bolt, if we apply an additional downward load of 4,000 pounds to the eye attached to the bottom of the member *B*, the total load upon the bolt will become 8,000 pounds. If, however, the original compression of the spring (due to screwing up) was 2 inches, and the corresponding extension of the bolt was .02 inch, the additional load of 4,000 pounds would stretch the bolt nearly .02 inch more, and allow the spring to extend the same amount; or the spring would be left with a total compression of $2 - .02 = 1.98$ inches. The bolt would then be subjected to the second load of 4,000 pounds $+ \frac{198}{200}$ of the initial load, or to $4,000 + 3,960 = 7,960$ pounds. This result is not precisely right, for the true load would be somewhat greater than the value just found, but this is sufficiently "fine," even for the purposes of a discussion of this nature.

Now, referring to Fig. 2, the bolt is in the form of a spring, and when this spring bolt is screwed up so that the initial load is 4,000 pounds, the legs of the piece *B* press against the piece *A* at *m* and *n* with a total force of 4,000 pounds (2,000 pounds on each side). This action extends the bolt (spring) and compresses the legs of *B*; but as the former distortion is very great in comparison with the latter, we will again consider the piece *B* as absolutely rigid for an approximate analysis. Upon adding a downward load to the eye of *B* (Fig. 2) the pressure between *A* and *B* at *m* and *n* is reduced by an amount equal to this downward force upon the assumption that *B* and *A* are absolutely rigid, and if this additional load is 4,000 pounds, the pressure at *m* and *n* will become zero, or the total load on the bolt will be but 4,000 pounds.

This conclusion is subject to such a modification as that referred to in connection with the case of Fig. 1, but with the great difference in rigidity which we have in the conditions here, this modification is slight. The actual load would be slightly more than 4,000 pounds.

Now let us go a little further and see what occurs when the load applied to the eye is not the same as the initial load due to screwing up. We will first take the arrangement of Fig. 1, and assume that the load applied to the eye is 6,000 pounds (the initial load being 4,000 as before). Upon the assumption of absolute rigidity, the total load on the bolt will be $4,000 + 6,000 = 10,000$ pounds. If the added load be but 2,000 pounds, the total load will become $4,000 + 2,000 = 6,000$ pounds.

Or, if we take the case of Fig. 2, the addition of a load to the eye of 6,000 pounds will extend the spring beyond the extension under the initial load, the contact between *A* and *B* at *m* and *n* will no longer be maintained, and consequently the load applied to the eye will be the total load on the bolt (spring). If, however, the load applied to the eye is less than the initial load, say 2,000 pounds, it will not change the load on the bolt, which will still be the load due to screwing up only.

This last conclusion follows from the fact that the final load cannot act to reduce the load due to screwing up, and if it puts a load on the spring greater than this initial load, the contact at *m* and *n* will be broken, and the bolt will have the second load only. As we have assumed this second load less than the initial load it cannot extend the bolt farther to produce such a result, and its only effect is to reduce the pressure between *A* and *B* at *m* and *n* without affecting the load on the bolt.

The above discussion may be summed up thus: In the case of Fig. 1, assuming absolute rigidity of all members except the spring, the load on the bolt is equal to the *initial load plus the added load.*

In the case of Fig. 2 the total load upon the bolt (spring) is equal to the *initial load alone* or to the *added load alone, whichever is the greater.*

In the former case the total load is actually somewhat smaller than that just indicated, because none of the members are absolutely rigid, and in the latter case the actual load is somewhat greater than the above statement gives, for the same reason.

In a practical case, the total load may be anything *greater than* the *initial load* or the *applied load* (whichever is the larger), or anything *less than the sum* of the two.

The bolt used to fasten a blank flange to a pipe, as in Fig. 3, approaches the conditions of Fig. 1, while a long bolt through a heavy hollow column, as shown in Fig. 4, approaches the conditions of Fig. 2. This latter is especially true when the long bolt is reduced for the greater part of its length to a section not exceeding the cross-section at the bottom of the threads, as is frequently the case.

Ithaca, N. Y. John H. Barr.

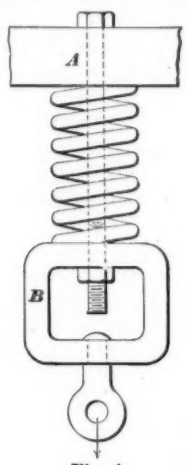


Fig. 1

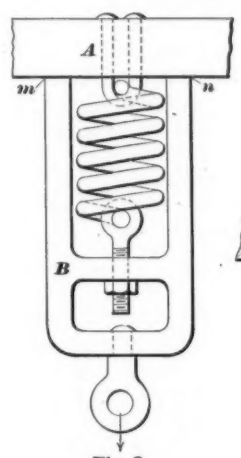


Fig. 2

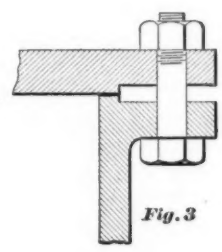


Fig. 3

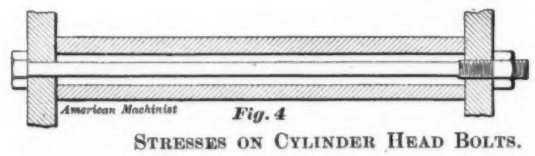


Fig. 4

Stresses on Cylinder Head Bolts.

Some Chips Made by Modern Lathes.

Editor American Machinist:

We have noticed several articles in your paper recently in regard to the requirements of metal-working machinery and its adaptability for taking heavy chips when necessary.

We recognize the fact that every manufacturer makes an effort to make patterns and forgings as close as possible to the finished size in order to reduce the cost and labor of finishing; but in every shop there are times when it is necessary to remove an unusual amount of stock from a casting or forging, and we claim that all machine tools should be made to meet this emergency, and in designing our tools this idea is always kept in mind.

Wishing to get an idea of what our lathes could do in this direction, we made a trial of some of the smaller sizes a few months ago, and although in no case were the lathes tested to their limit we think the result was very satisfactory.

Thinking that on account of the recent articles in your paper, you may perhaps feel a personal interest in the matter, we send you by this mail a sample of the chips taken off at the time mentioned, you will find on each box the size of the lathe used in cutting the chip, and we enclose a table showing diameter of stock, speeds, etc.

J. L. Chapman, Supt. and Treas.
Fitchburg Machine Works.

[The table referred to by Mr. Chapman is as follows:]

(Test made April 15, 1895.)

* Belts, all single, on middle step of cone, except on 30-inch lathe, which is on the second smallest step; 14-inch double T-rest. All others compound. Stock, Bessemer steel.

Lathe.	Diam. stock.	Diam. red. to.	Cut.	Feed. per in.	R.P.M.	Feed per min.
14″ No. 252	2¼″	1″	9/16″	36	17	1/16″
16″ No. 262	3″	1 5/16″	1/8″	36	22	1/16″
18″ No. 269	3″	1½″	¾″	32	15	1/16″
21″ No. 258	3 3/16″	1 11/16″	3/16″	30	13	1/16″
24″ No. 255	3 3/16″	1 5/16″	1″	28	13	1/16″
30″ No. 266	4 1/16″	2″	1¼″	28	12	⅛″

[The figures given in this table speak for themselves, and the chips mentioned show great cutting power and steadiness of action. They were evidently taken dry. The chip made by the 14-inch lathe is 1/16 inch wide and about 3/64 inch thick; that made by the 21-inch lathe is 1 1/16 inches wide, and about the same thickness; that made by the 24-inch lathe is 1⅛ inches wide and the same thickness; that by the 30-inch lathe is 1 5/16 inches wide, and very nearly 1/16 inch thick. All the chips are curled.—Ed.]

Tom Sees Some Shops.

Editor American Machinist:

My boy Tom has developed a liking for machine shops, and Saturday afternoons when he should be working around the house, he is more often found in some shop supremely happy and also dirty. Now, in common with many others who follow the machinist trade, I find it something more than simply a means by which to get a living, and naturally the boy is imbued with more or less of the same ideas. His critical faculty seems somewhat developed, as you may see from some of his remarks on shops.

"Well, I was over at A.'s shop to-day, and I see they are putting up a new building. Queer way they have of getting along. You remember their old shop and the way things were fixed. Did not seem half room enough, but they got out a lot of work. The fellows all were interested in seeing how much work they could turn out, and what a contempt they had for the old C. shop because they were slow and old-fogy.

"There was that old pulley lathe. Could turn any pulley that swung under the ceiling. The spindle was about three inches diameter, the ways cast-iron rails on wooden beams and the feed the old crank and ratchet affair. But it could turn an eight-foot pulley in very fair shape, and the man who ran it was proud of the amount of work he could turn out.

"Then their shafting lathe. It was not very much of a lathe, but the man on it turned out a lot of shafting. The follower had three tools, two roughing and one finishing, and the shaft was kept steady by hard wood blocks. An old white-lead keg did duty as a pump. Feed about 6 or 8 to the inch, and the man on that lathe was a hustler.

"There was no system in the shop, but it had the advantage of being so small that the space in which to lose things made it fairly easy to find them again. There were lots of bosses, some seven in all. Sometimes a man had work from four of them at once. However, it seemed necessary to move, and the old C. shops being then vacant they moved in there. You may see how things were going on.

"Well, they moved into the other shop and then needed an office some distance away from the shop, and a new residence was also built. For some reason the men did not work so hard in the new place. It may be that the ghosts of the old men and their fine feeds, or the high collars of the office men, or else the shop being so large the men did not feel their old importance. At any rate, the old friendly feeling has gradually died out, and there is no good system of foremanship to take its place. Why, suppose a foreman was to give a man a piece of work, and the proprietor was to come along and wanted another job, he would say, 'Oh, to blazes with him; I want you to do this.' Of course, he can't get any kind of a man to stand that. The manager tries to spread himself everywhere, and as he can't be over two or three acres at once, things don't go so very well. I don't know why he wants to build another shop, unless to make a final splurge. They are not very

busy in this one. And just the sort of building you might expect—a light and shaky affair. I don't see how a man can do such work in these days."

There is another shop in town, a small one, and the young man seems to have taken notes there.

"Down at B.'s shop things are not any better. There the two of them work all day just like any other machinists. Only one or two men to help them, and each of the owners is afraid the other may have too easy a time. One of them kept the books, but as the work increased and he had off his overalls for a part of each day, the other could stand it no longer, and he had to come back to the shop. There they work all day and seldom read anything. One of them told me he used to take the AMERICAN MACHINIST, but found so few things in it that were any good he gave it up. They never go after work, and I suppose some day they will be wondering why they have such ill luck."

Perhaps by seeing these shops and noting their bad qualities, he may be better able to appreciate the better class of shops when in time he tramps. C.

Lathe Indicator.

Editor American Machinist:

Nearly a year ago I made myself a lathe indicator that has since proved so useful that I will venture to offer sketches of its construction and use in the hope that they may prove interesting to some of your readers. I do not claim any originality on the idea of the thing as a whole, but only on some of the details, and a few of the applications in use. The germ of the idea is embodied in the instrument shown by Mr. Frederick M. Bush in your issue of April 23, 1891, who credits it to Mr. James Shaw. I took Mr. Bush's multiplying levers and developed them into pinions, segmental gears and a rack, and thus enlarged the range of movement to $\frac{1}{10}$ inch, which, although not absolutely necessary, is sometimes exceedingly convenient.

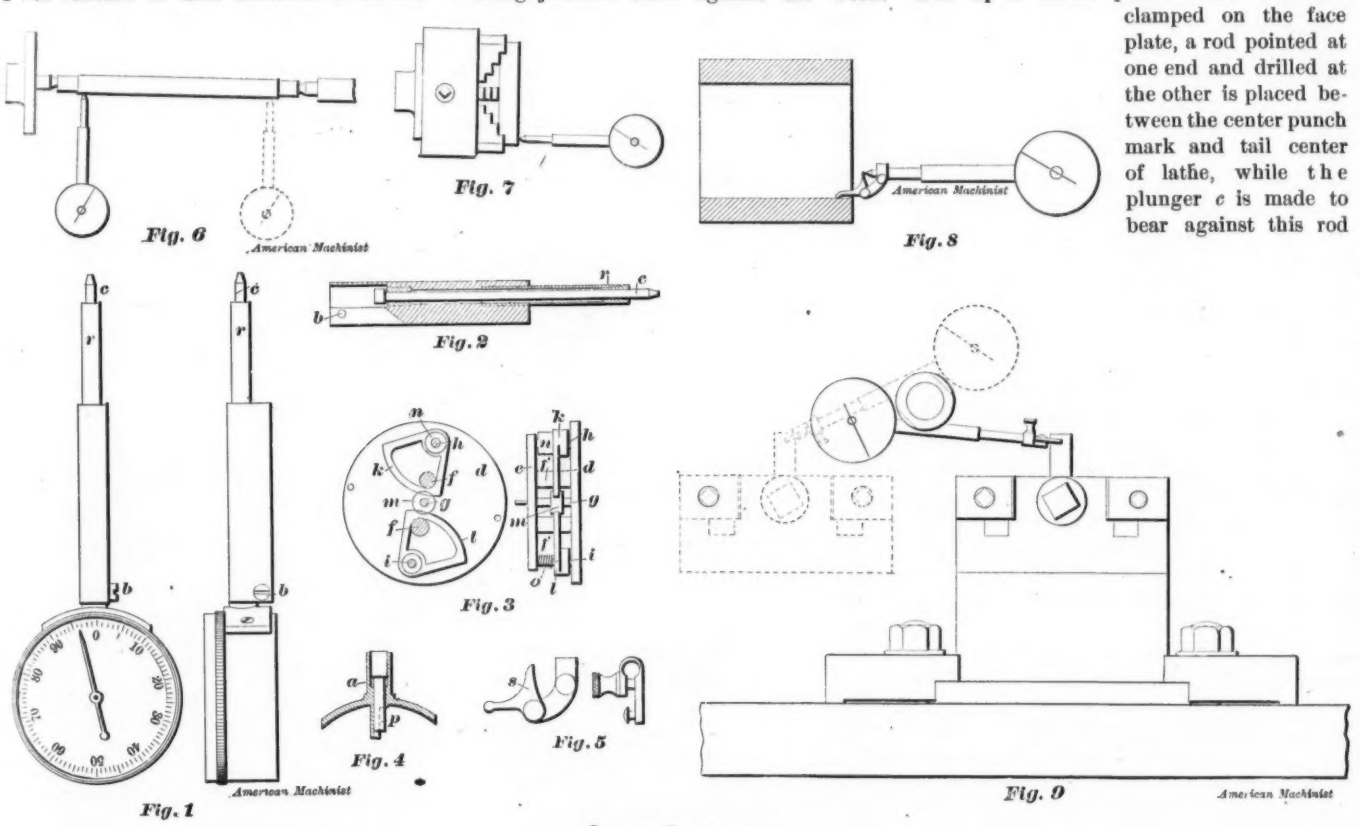


Fig. 6 Fig. 7 Fig. 8

Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 1 Fig. 9

LATHE INDICATOR.

Fig. 1 shows a plan view and side elevation of the instrument as it is ordinarily used. The hand on the dial makes one complete rotation for $\frac{1}{10}$ inch movement of plunger *c* (but has a slight margin over one turn), and as the dial has 100 parts, each part corresponds with .001 inch movement of plunger. The shank of the instrument that goes in tool post of lathe is shown in section in Fig. 2. The back end of this shank is bored out $\frac{1}{4}$ inch to take the round stem *a* of the piece shown in Fig. 4, which is fastened to the gear box by two small screws. The bottom of the shank is split, and closed by a clamping screw *b*, so the gear box can be rotated in relation to the shank, and clamped in any position. This is sometimes an advantage, as it enables the dial to be turned towards the light. The shank contains a long plunger *c* of round wire, hardened at its outer end, and having a head riveted on its inner end to keep it from dropping out when in use. The plunger has a bearing at each end (the outer bearing hardened), but does not touch the shank for the greater part of its length. The top of gear box has the dial engraved on it, and over this is screwed on a glass cover to protect the hand.

The bottom plate of the gear box is shown in plan and elevation in Fig. 3. It consists of a round plate *d*, to which the bridge piece *e* is fastened by two posts *f f*; *d* and *e* form the bearings for the center shaft *g*, and the two segment shafts *h* and *i*. The two segments *k* and *l* both mesh into the center pinion *m*, but *k* has fastened to it the pinion *n*, while *l* has a spiral spring *o* around its shaft to return the hand to zero, and always keep the backlash in the gear teeth taken up in the same direction. The piece *a* in Fig. 4 contains a short plunger *p*, which has a few rack teeth cut near its inner end that engage the teeth of pinion *n*. The plunger *p* is purposely made with a shoulder against which it strikes at the inner end of its stroke just before the segments strike the posts *f f*. This is to save the delicate gear teeth from injurious strain in the event of the plunger *c* being jammed hard against the work. When the instrument is assembled the two plungers *c* and *p* come together, and the former can push the latter in, which actuates the pinions and segments, and, of course, the hand on the dial, but when the pressure is entirely or partly removed from the outer end of *c*, the spiral spring *o* returns all the parts to their normal position, or as near to that position as the plunger *c* will admit of. The rack teeth on plunger *p* are 20 per inch, while the pinions *m* and *n* have each 12 teeth, and the segments *k* and *l* are portions of a 72-tooth gear.

Fig. 5 shows the hole indicator attachment in plan and elevation. It is a curved piece that clamps on the outer bearing *r* of the plunger *c*, and carries the bell crank *s*, one end of which bears against the plunger *c*, and the other against the bore of hole (the bell crank *s* is not shown in elevation).

Fig. 6 shows the application to an ordinary lathe job. By putting the arbor in between centers and the indicator in the tool post, the arbor may be turned around with the fingers while the lathe spindle is at rest, and the plunger brought in contact with it; if the hand stands still on the dial it will show that the arbor is true, but if the hand moves the amount of movement shows the amount of eccentricity of the arbor, and the parts of the arbor in contact with the plunger when the hand is at either end of its travel will be the high and low spots respectively, which it is sometimes convenient to know. By placing the plunger near left-hand end of arbor, starting lathe, but holding arbor from rotating, we can test the truth of the live center. By reversing the arbor in the lathe, and moving indicator towards right-hand end (as shown dotted), but without moving cross slide, the alignment of lathe can be tested, both for direction and amount.

Fig. 7 shows the application to a piece chucked a second time, where it is desired to get the part turned at the first chucking to run true, the indicator showing just where to hammer it, and how much. In this position the indicator may also be used to test the end shake of the lathe spindle, to tell if the face plate runs true, and whether the lathe faces flat or dishing. Fig. 8 shows how a hole may be tested for truth by means of the bell crank attachment. With this indicator a piece of work in an independent 4-jaw chuck may be trued in a surprisingly short time, and if the work is much out of round, and not much of a cut to come off, as is the case with very many castings, the indicator is almost invaluable, as it will show when the two opposite low spots are the same distance from the center line, or in other words, when we have the casting chucked so it will clean up to the largest possible dimensions. When used to true up a center punch mark in work clamped on the face plate, a rod pointed at one end and drilled at the other is placed between the center punch mark and tail center of lathe, while the plunger *c* is made to bear against this rod as near to the work as possible, the rod not being allowed to rotate with the work.

Fig. 9 shows the application of the indicator to setting the spiral bed of a milling machine at exact right angles with the spindle, which is not a very easy thing to do when you have to depend on the graduations on the machine, even with the best light and best of eyesight, and if a deep slot is to be cut with a mill of large diameter, the teeth will drag on one corner unless the bed is set accurately square with the spindle. The indicator is held in the arbor between one side of the washers. Screwing up the arbor nut with the fingers holds it tight enough, and does not bend the arbor, which might happen if a wrench was used. The bell crank attachment is brought in contact with a small block held upright in vise jaws, and the contact tried first at the right and then at the left of arbor, and if the indicator reads the same in both positions, the bed is correctly set, but if the readings are different, then the bed should be set around till the hand stands at the mean of the two original readings. The vise jaw itself might be used in place of the small block shown, only the vise should have been previously set parallel with the bed by letting the jaw travel past the bell crank, and noting if there was any movement of the hand. By holding the shank vertically and turning bell crank attachment through a quarter turn from the position shown in Fig. 9, it can be used to set the vise jaws parallel with cross slide.

Not long ago I used it with good effect in a shaper; placed in the tool post, with plunger in contact with surface of shaper vise, it showed me the bottom of vise was neither parallel with ram in one direction, nor with the rail in the other direction. Then with the ram at rest, I slid two alleged "equal parallels" under the plunger of indicator, and found out that they were neither parallel nor alike, but the error was not very large, so by placing the thick end of the largest parallel on the lowest part of vise, and the thin end of smallest parallel on the high spot of vise, I got my work planed up much nearer parallel than if I had gone at it haphazard. One of my friends suggested placing the indicator on the end of an arm held in drill press chuck, and letting plunger travel around the table near its edge to test for squareness with spindle, which I intend to do some day, but haven't got about it yet. There are quite a number of uses aside from lathe jobs to which this tool may be put, so it hardly merits the name of *lathe* indicator.

WALTER GRIBBEN.

The Angle of Centers for Large Lathes.

Editor American Machinist:

Your article on the subject of "Lathe Centers," in your issue of June 6th, is an initiative step towards remedying a certain evil which has existed or does exist in nearly every shop in a more or less aggravated form.

In my experience, up to a certain date, I, as well as my shop associates, labored under the delusion that the angle of the centers for large lathes, exceeding 30 inches in swing, should be 90 degrees.

A 36-inch lathe was used for doing both heavy and light work, and for that reason was equipped with two pairs of centers, one pair 60 degrees and the other 90 degrees. Somehow or other the 90-degree centers were always in poor condition when needed which necessitated the use of the 60-degree set for a heavy repair job which was required in a hurry. With many misgivings on the part of the lathesman, the piece was placed between the centers and finished without any of the imaginary difficulties looked for.

This experience resulted in the use of the standard angle of 60 degrees for all lathe centers regardless of size of lathe or class of work in my charge. E. A. MULLER.

Springfield, Ohio.

Wants Information About Soldering.

Editor American Machinist:

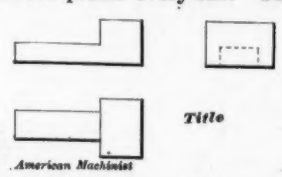
Can you or any of your readers give me a quick method of soldering the wire eyes to brass-button blanks. P. C.

New Haven, Conn.

Projecting Drawings.

Editor American Machinist:

"Chordal," in one of his letters, speaks of successful things that won't do. I am reminded of that saying in reading the articles in the AMERICAN MACHINIST on "Proper Methods of Projecting Drawings." One concern employing about 500 men has a method which should please every one. The views



are made as shown in accompanying sketch. One set of men may look at two of the views and be happy, while the opposite set may pick out the two views pleasing to them.

This scheme leaves room at the lower right-hand corner for the title, that being the reason for placing the plan underneath instead of above the elevations. The system gives no trouble, and while at first new men may declare it all wrong they soon become accustomed to it. WM. SANGSTER.

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"Impulse" Engines Without the Impulse.

To invent a new word, or even a new application of a standard word, is to incur a great responsibility in any event, and in the case of an incorrect application of the word it may cause serious trouble and misunderstanding. Someone has begun the practice, and now it is quite a common one, of speaking of the gas and oil engines of the day as "impulse" engines. The idea intended to be conveyed, of course, is, that the power developed by the engine and taken from the driving shaft for practical uses is first imparted to the piston suddenly and all at once, at the instant that the explosion occurs. The use of the word "impulse" in this connection, meaning by it a sudden application of force, is incorrect, misleading and libelous. In speaking of the ignition and rapid combustion of the charge as an explosion, we are probably contributively culpable. The expression suggests not only an unsteadiness of revolution in the engine much greater than actually occurs, but also strains upon bearings, connections and frame that never are encountered. We mentioned not long ago the desirability of some movement for the steam-engine indicator which would enable it to show us clearly what goes on in the cylinder while the crank is passing the center, and the transitions of the steam currents are taking place. We have now in the gas and oil engines another place where such an arrangement is peculiarly desirable. We should be able to trace the ignition of the gas and the rise in pressure during the combustion. We know that it takes time. We know from our present indicator evidence that the increase in pressure is not in the nature of an instantaneous shock or of a blow struck any more than the admission of steam in the steam cylinder is a sudden blow, because we see that the movement of the pencil of the indicator is not sufficiently rapid, and that it does not acquire momentum enough to carry it beyond, or more than slightly beyond, the actual pressure attained and represented. The indicator tells us even now that these engines, so far from being "impulse" engines, or being driven by a blow like that of a sledge upon the piston at the beginning of the working stroke, are instead more truly expansive engines than any steam engine that ever existed, and that the driving by expansion continues for the entire stroke, while in the steam cylinder the expansion is only for the portion of the stroke remaining after the cut off. No steam engine runs by expansion alone as the gas engine does. There is always a certain portion of the stroke, when the cylinder is filling with steam, and by its pressure driving forward the piston, which certainly does not do that work by the expansion of that charge of steam; and only after the cut-off is the work of expansion done. But the diagram from the gas engine shows us that with it "cut-off" has occurred before the beginning of the stroke, and the entire force of the driving stroke, from the beginning to the end of it, is due to the continued expansion of the burnt gases contained in the combustion chamber and in the clearance spaces at the beginning of the stroke. Of course, we understand that in these engines every stroke is not a driving stroke, and that in some of them the intervals of intermission vary according to the power or speed requirements, but we must protest that to call the engines "impulse" engines gives us no hint of this peculiarity, but that it does give us a hint of something that does not exist.

The Development of the Steel Building.

The tall office building is one of the modern wonders. What all may not perhaps as fully realize is that it is also almost entirely an American product. Our transatlantic cousins freely acknowledge this. A leading English publication, in a recent illustrated description of some of the tall structures lately erected in New York, Chicago and other cities, says that "they are really very wonderful in their way, and mostly unlike anything we have in Europe." The Parisian papers also have illustrated and described these buildings, Frenchifying and adopting the word mostly employed to designate them as "*le sky-scraper.*"

That these buildings are a pronounced improvement upon the old, and an undoubted success, is attested by those who occupy and use them, by those who own them, and by those who are still hurrying to build them faster and higher. Their advent is so evidently an improvement as to suggest the customary question as to why we have not had them long ago, and the ready answer is that they have only been possible within the present generation of men. They are the combined product of the modern methods of producing steel, of the passenger elevator, the electric light and the telephone. The inventor and the mechanic have produced them, and none can more fittingly still study and discuss them.

It is easy to believe that these buildings being of so recent growth, are, perhaps, not yet fully developed. In the long run no profession has a surer grip upon the human race and its belongings than that of the architect. Sooner or later he has his say, and he has not yet had his say as to the modern building. The building has grown more rapidly than the man, but we must believe that he will eventually overtake it.

The essential change thus far in the building is in the material employed, and this has changed the method of erection, and reversed the function of the principal elements of it. The entire area covered by the building is now its foundation, and the external walls instead of being the principal support of the building, and carrying all the floors and the roof, are now themselves supported instead. This reversal of function has made some of the things now perpetrated in the name of architecture absurd. These buildings still pretend to be of masonry, when they are not, and, while they present to the eye the appearance of massive structures of stone, if they actually were what they seem to be they would tumble down. One building shows in its front a vast rectangular opening taking in the second story, and in the flat top of the opening is displayed a central wedge or keystone, and ranging away on either side of it are successive stones with their sides radiating from the assumed center of the "arch," the whole arrangement being supposed to support a dozen or more stories of building above it. The superstructure is really supported, as are the visible stones themselves, by a massive steel beam. In another building this great opening, so necessary for the traffic in and out, shows a number of graceful Ionic columns that, if they were not a mere pretense, would inevitably be crushed by the weight of the twenty stories that tower above them.

These things ought not so to be. In the complete development of the steel order of architecture they will not be. Steel will be seen and known to be what it is, and will be trusted and credited justly. None may say in advance what we shall see, but we shall see the truth, and we shall not sacrifice any essential, as we are still often sacrificing one-half of our light, to the pretense of brick or stone. We might have larger windows and the building would be lighter within and have a much lighter appearance without. In the new order we would have no use for the stone mason except for the foundation. The building might all be made in the steel works, and with the foundation ready it could go up like a circus tent. This suggests the ready transportation of the modern building, and it suggests a much larger thing. It suggests the possibility of supplying the world with buildings after the steel order of architecture. There may be in this the promise of as great an export trade as in that of any American manufacture.

There will be no meeting of the Western Foundrymen's Association in August; arrangements are being made to hold the September meeting in Milwaukee, Wis., particulars of which will be announced later.

Accuracy on Gun Work.

Our contemporary the *Engineering News* comments upon the wonderful accuracy of modern machine shop manipulation, basing its remarks upon the alleged fact that in seven 12-inch rifles recently turned out at Watervliet Arsenal there was a variation in weight between them of only 5 pounds; the total weight of each gun being 115,000 pounds. Our contemporary says:

Instead of a jacket a series of hoops are shrunk on the inner tube for nearly the whole length of the gun, and over this is shrunk a single jacket, covering about two-thirds of the length, and then another layer of long hoops. When the intricacy of this assembling process is considered in connection with work done on lathes capable of handling guns 40 feet long, the close agreement in weight is almost phenomenal.

As the hoops are shrunk on in such a manner as to make the gun practically solid it evidently can make no difference how intricate or how simple the system of hoops may be. If a hoop should be bored too large, its seat would be turned to fit it. This confines the field for variations of size and weight to the bore and to the exterior of the guns. We figure that a cut .001 inch thick taken out of the bore of the gun—enlarging it .002 inch—would weigh nearly 2.7 pounds, and from this it is seen that a variation of 5 pounds, caused by variation in size of bore, would mean a variation of diameter of something over .004 inch, which would be anything but close or accurate work.

On the other hand, if we suppose the bores of these guns to be within a much smaller limit (as they should be and probably are) and assume them to be alike, then the 5 pounds variation must be caused by variation of outside diameter or in length. Assuming the mean outside diameter of the gun to be 24 inches we find that a variation of .001 inch in diameter here would almost exactly make 5 pounds variation in weight, and, if made within any such limit outside, it is a case of sadly misapplied skill and useless work.

The fact is, however, that limits of variation in machine shop work are not based upon the diameter or weight of the work, but may be just as close on work 12 inches diameter as on work 1 inch diameter.

It is quite well understood among machinists that the limit of variation in lathe work is not proportioned, or is not, as our contemporary would probably say, "a function" of the diameter of the work. Large work may be, and frequently is, done to as close limits as watch work, and is usually done much closer in proportion to its actual size, if that were considered to be of any especial significance.

English and American Nomenclature.

A British writer in starting an editorial says, somewhat incidentally: "It is a pity that our industrial technical terms have drifted so widely apart, that many American writers are obscure, if not unintelligible to Englishmen. We do not mean to say that we have right on our side in every case, for there are many cases in which the Americans have the advantage in conciseness; they say 'planer,' while we say 'planing machine.' At the same time we say 'dredger,' an inconsistency, if the other term is correct. We use in common the term 'shafting,' but while we have abandoned the word 'arbor,' as applied to shafts, and adopted from the French or Latin, the American uses 'arbor' to distinguish what we call a mandril and what is called in France a *mandrin*. Evidence seems to be in favor of the *mandril*, a term to distinguish a temporary axle or shaft from a permanent one."

Here we evidently have the advantage of the Englishmen, as they seldom succeed in writing anything that is unintelligible to us, at least as far as the meaning of the words is concerned. We use both arbor and mandrel as we choose, and each is intelligible and satisfactory to us, and we sympathize with the people to whom the one of them is a stumblingblock. We do not use such a bizarre expression as "upkeep" instead of the good, old word maintenance, and we say "right of way" instead of "way-leave."

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(307) W. E. S., Newark, N. J., writes: Please give me a formula for determining the heat required for enameling. *A.*—The heat required depends on the kind of work to be done; the substances are fused by the heat of a small furnace, or by the flame of a blow pipe. No formula can be given, skillful manipulation and experience are essential for successful results.

(308) H. W. B., Wenonah, N. J., asks: What is the method of least squares and how is it accomplished? *A.*—The method of least squares is one of obtaining the most probable value of a quantity from a set of observations made to determine it in accordance with the principle that the sum of the squares of all the errors is to be made a minimum, used especially in astronomy and geodesy. For the application of this method we must refer you to books treating on this subject. 2. Please give me a good method of pickling iron castings. *A.*—Mix vitriol, 1 part, water, 2 parts. Wet the surface of the casting well with this solution, by the means of a ladle, or a cloth tied to a stick in the form of a brush, and let the casting stand for about 8 or ten hours, then wash it off with water.

(309) O. O., Philadelphia, Pa., asks: Is there a rule or formula for computing the dimensions of the parts of a small steam engine which is to be built from the drawings of a much larger one, so as to preserve the relative strength of the parts? And does such a rule apply to the diameters of cylinders as well as to diameters of shaft, rods, etc? *A.*—There is no such rule. The large drawing will show the type of engine which is to be followed, and this is the only purpose for which it can be used. In designing an engine the diameter of the cylinder, stroke of piston and speed suitable for the work which the engine will have to do should first be determined. The dimensions of the parts should then be computed independently of the dimensions on the large drawing. Rules for computing the sizes of the different parts are given in books treating on the steam engine, but since the rules as given by different authorities for determining sizes of similar parts are sometimes conflicting it is necessary that the designer should have experience. Again, some of the rules which give satisfactory results in designing large engines will have to be modified, as experience and sound judgment may dictate when applied to the design of very small engines.

(310) C. B. H., Montreal, Canada, asks: How can a bicycle handle be bent without buckling, or brought to its original shape without an unsightly dent? *A.*—There are two ways of accomplishing this: First, fill the tube with melted rosin and let it cool; then grip the tube in a vise between soft pine pieces, and bend it cold to the required shape, after this, heat the tube to melt the rosin, and allow it to flow out. The other way is as follows: Make a form or template of pine about 1½ inches thick, and cut the edge to conform to the required bend of the handle bar. Cover this edge with a strip of asbestos, and in the center of the curved portion of the edge bore a hole to receive the shank of the bar, and then clamp the template, with the curved edge upward, in a vise. Now heat 2 or 3 inches of the handle bar in the center in a Bunsen flame to a dull red, and then bend it over the form. In a similar way, by heating 2 or 3 inches at a time, the whole length of the bar can be bent. The asbestos will prevent the burning of the wood. A handy arrangement for heating conveniently the handle bar at any desired spot, is to attach to the Bunsen burner two rubber tubes of considerable length leading to the gas and compressed air pipes which may be situated at some distance from the bench. Place upon the bench a cast-iron plate, and on this arrange fire bricks in such a way as to confine the flame to the part to be heated. Such an arrangement will not only be handy for heating the handle bars, but for many other small jobs that may come along.

(311) M. M., Evanston, Wyo., writes: Please inform me if there is a book published on the practical management of electric lighting and of power plants, if so, please give publisher's name; also state where S. P. Thompson's book on "Magnetism and Electricity" can be obtained. *A.*—"Practical Treatise on Electric Lighting," by W. E. Sawyer, and "The Practical Management of Dynamos and Motors," by F. B. Crocker and S. S. Wheeler, may suit you. These books are published by D. Van Nostrand Company, 23 Murray street, New York. "Magnetism and Electricity," by S. P. Thompson, you can obtain from the same firm. 2. I have a cylindrical tank, the inside dimensions of which are 60 inches diameter and 120 inches high. I have placed it on its side, and have graduated one of the ends in inches, and now want to show the number of gallons contained in the tank up to each inch. Please give formula for computing the same. *A.*—Find the area in square inches of each segment terminating in its respective chord drawn through the inch mark. The rule for finding this area is given in answer to Question 299 in our issue of August 1st, current volume. The quickest way will be to find the area of the lower segment first, and then find the area of each succeeding segment up to the center, then subtract the area of the lower segment from the whole cross-sectional area of the tank, the result will be the area of the segment up to the chord drawn through the highest inch mark; then subtract the area of the second segment at the bottom from the whole cross-sectional area of the tank, the result will be area of the segment up to the chord drawn through the second inch mark from the top. In a similar way the areas of all the segments reaching to chords above the center of the tank are found. Lastly, multiply the area of each segment by the length in inches of the tank, and divide these products by the number of cubic inches in a gallon, 231, the results will be the number of gallons in each segment.

(312) W. W., Buda, Ill., writes: Kindly give me some points on brazing. I have jobs of every description in this line, but I have no tools in the way of a special forge or blow pipe, but simply a smith's fire, and it will not pay to rig it up, as the jobs are far between. I simply want points as to whether the pieces to be brazed must be cleaned, kinds of spelter, borax, etc. *A.*—The materials necessary for brazing are the brazing solder and the pulverized borax, which acts a flux. The principal ingredients of the brazing solder should be copper and zinc; the proportion of the latter will govern the hardness; 2 of copper and 1 of zinc is often used for brazing; 1 of copper and 1 of zinc is more fusible. This solder can be bought of any composition. Trouble may be avoided by using a suitable kind of borax, of which there are three kinds—the plain borax, borax which has been dried or calcined, and borax which has been melted and then broken to a coarse powder. The first kind when heated will swell, and does not flow readily over the surface. The second kind is nearly free from this defect. The third kind has nearly all the water driven out of it, and therefore forms a perfect covering for the metal. The common practice is to use some of the calcined borax and some of the melted borax with which the joint is covered. All the parts which are to be brazed must be thoroughly cleaned; rust, oil, or any foreign matter must not be allowed to remain. Make a fairly good joint by filing or scraping the surfaces which are to be united, a perfect joint is not needed, nor desirable. Place the pieces in their proper relative position, and bind them securely together with binding wire or clamps. Now heat the pieces over a clear charcoal or coke fire, and in the meantime have close at hand two shallow boxes, one containing borax, and the other a mixture of borax and spelter, about two parts of spelter to one of borax, by measure. In heating the work hold the brazing spoon where it will become as hot as the work; when the work begins to redden dip the spoon into the borax, when a portion will adhere to the heated metal, and may be wiped into and around the joint. After the flux has been thoroughly applied to all parts of the joint, and the heated metal comes near the brazing point, dip the spoon, which must always be kept hot, into the mixture of borax and spelter, and apply as before, wiping it into and around the joint. When it is certain that the spelter has penetrated all parts of the joint, remove the work carefully from the fire and allow it to cool, care being taken that none of the pieces are moved relatively to each other until the spelter has set, then use a metal brush, and remove rapidly the borax, which does not harden at quite as high a temperature as the spelter. The above refers to such work only as may be met with in a machine or repair shop. Skill and experience are the most essential requisites for making good joints; for it does not follow that when the joint has a good outer appearance it is a perfect one; unless the spelter has flowed throughout the joint, disappointment will be the result. It is here where experience and carefulness are of the greatest importance.

(313) S. C., Boston, Mass., writes: Kindly give me a rule for computing the cooling surface in a condenser for single or compound engines. For instance, find the cooling surface for a 17x18-inch marine engine, steam pressure, 100 pounds: speed, 180 revolutions per minute, cutting off at half stroke. *A.*—When the temperature of the sea water is about 60 degrees you may use the following number of square feet of cooling surface for one indicated horse-power at the given terminal pressures:

Terminal pressure,	30	lbs.	absolute,	2.2	square feet.
"	20	"	"	1.7	" "
"	15	"	"	1.57	" "
"	12½	"	"	1.50	" "
"	10	"	"	1.43	" "
"	8	"	"	1.37	" "
"	6	"	"	1.30	" "

For ships whose station is in the tropics the allowance should be increased 20 per cent., and for ships which occasionally visit the tropics, 10 per cent. increase will give satisfactory results. If a ship is constantly employed in cold climates 10 per cent. less will suffice. If, for instance, the engine develops 175 horse-power, with a terminal pressure of 20 pounds, you will need about 175 × 1.7 = 297.5 square feet of cooling surface in the condenser. Of course, cutting off at half stroke the engine will develop a greater horse power, but it seems to us that on a steamship you will endeavor to use the steam more economically. 2. I would also like to know the rules for computing the sizes of air and circulating pumps. *A.*—In practice it is usual to make the air pump proportional to the capacity of the cylinder or cylinders exhausting into the condenser. The following table gives the ratio of capacity of cylinder or cylinders to that of the air pump; in the case of the compound engine, the low-pressure cylinder capacity only is taken:

Description of Pump.	Description of Engine.	Ratio.
Single-acting vertical.	Surface condensing expansion .. . 1½ to 2	6 to 8
"	" .. . 3 to 5	13 to 16
"	Compound engines.....	18 to 24
Double-acting horizontal.	Surface condensing expansion..... 1½ to 2	13 to 16
"	" ..... 3 to 5	19 to 24
"	Compound engines.....	24 to 28

The size of the circulating pump is to a large extent dependent on the same conditions that determine the size of the air pump, and may therefore bear a constant relation to the size of the cylinder. The following table gives the ratio of capacity of cylinder or cylinders to that of the circulating pump:

Description of Pump.	Description of Engine.	Ratio.
Single-acting.	Expansion..... 1½ to 2	13 to 16
"	" ... ... 3 to 5	20 to 25
"	Compound	25 to 30
Double-acting.	Expansion .. ... 1½ to 2	25 to 30
"	" ..... 3 to 5	36 to 46
"	Compound	46 to 56
"	Triple and quadruple...	56 to 64

For all these ratios it is assumed that the pumps have the same number of strokes per minute as the engine. You will find all the rules for marine engine construction in the "Manual of Marine Engineering," by A. E. Seaton.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 652.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Just issued—Catalog No. 8. Mailed Free. Clayton Air Compressor Works, 28 Cortlandt St., New York.

Wanted—Machinery to build: special, steam, mill, hydraulic. F.C. & A. E. Rowland, New Haven, Conn.

I make Fine Model Castings in Brass or Aluminum. Twining Campbell, Aluminum Founder, Paterson, N. J.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Aid to Engineers' Examinations, with Questions. Price $2, prepaid, catalog free. Theo. Audel & Co., 91 Liberty street, N. Y.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular, Norman W. Henley & Co., 132 Nassau street, New York.

American Machinery in France.

A mistaken idea has gained ground in many manufacturing circles of the United States that the great Republic of France, noted throughout the world for her manufactures and arts, has no place for the results of American skill. But a careful study of the French markets, and a thorough observation of the needs and demands constantly growing throughout the country will show that this country offers excellent opportunities for the active American to obtain a good, constant, and remunerative field for his products.

France had a population of 38,218,903 in 1890, and at the present date is not much larger, as the increase is not more than three-fifths of one per cent. in five years. In 1891, 17,435,888 were employed in the various branches of agriculture, and 9,532,560 in manufactures. The agricultural interests of France are of great magnitude and importance. It was estimated that in 1889 they represented a total value of $19,300,000,000, or 20 per cent. more than the total value of the farms of the United States, together with their live stock and machinery.

With regard to tariff, the French Government makes two classifications, applicable alike to both importations and exportations. The first, "general commerce," when applied to imports, comprises all merchandise coming from abroad, from her colonies, and the ocean fisheries, by land or by sea, for consumption, as well as for warehouses, transit, re-exportation, or temporary admissions, and when applied to exportation comprises all domestic or foreign merchandise that passes out of France. The second classification is "special commerce," and when applied to importations includes such merchandise as is left to the disposition of the importers, that is to say, all merchandise exempt of duty, and when it relates to dutiable merchandise, the quantities which have been subjected to duty. When applied to exportations it includes all domestic merchandise exported, as well as foreign merchandise sent back to foreign countries after having been admitted to franchise, or nationalized by virtue of payment of the import duties.

The existing duty on agricultural machines imposes, first, a general duty of $2.895 per 100 kilos of 220 pounds each, and secondly, a conventional duty of $1.737 per 100 kilos of 220 pounds on all agricultural machines. Stationary and marine steam engines are subject to duties of $3.47 and $1.31 for every 220 pounds, provided they weigh 550 pounds or over, and when less, to duties of $5.79 and $3.96 for every 220 pounds. Portable steam engines are dutiable at $3.28 and $2.50 for every 220 pounds; locomotive engines, when of ordinary gage, to duties of $3.96 and $2.89 for every 220 pounds, and when narrow gage, to $4.63 and $3.47. Hydraulic engines, turbines, pumps and ventilators to $2.89 and $1.93 for every 220 pounds, and tenders for locomotives to the same. General machinery, including transmission gearing, balances, scales, fixed railway stock, signals, presses, lifting apparatus, etc., to duties of $2.89 and $1.93 for every 220 pounds. There are other provisions, but the above will serve as a general outline of the existing tariff in France, so far as it relates to machinery. The method of basing the values of each article imported or exported is determined annually, under the direction of the Department of Commerce and Industry, by a committee of experts, who receive their information from chambers of commerce and other sources. These values are termed "actual values," and have for their object the determination, as accurately as possible, of the mean price of each article during the year for which they are given.

The total value of the imports of France in 1894 was $824,727,000, while her exports were $667,601,000. Of this total value of imports, the machinery imported from the United States was $497,000, as compared with $369,000 in 1893, and $920,000 in 1892. The total value of the imports of France in

1894 was $795,057,000, of which $71,655,000 was imported from the United States. The total imports of agricultural machinery in France in 1894 were 7,729,048 pounds, valued at $712,000.

Certain facts must be borne in mind as of especial interest to the exporters of the United States, and these, in the main, relate not only to France, but to Great Britain and Europe in general. For instance, with regard to agricultural implements, the Gallic farmer uses to day the same sort of a plow as was employed by the ancient Romans; his scythe looks like some rude tool made by the aborigines. France is fully a century behind the age, and strenuously resists all efforts to bring her up to date, but there is, at present, a grand opportunity for the mercantile houses of the United States to enter this greatly to be desired market. One of the serious objections urged hitherto by the few who have attempted to introduce their goods, is the reluctance of the French to buy foreign merchandise, and the extreme conservatism of purchasers generally. While it cannot be denied that this feeling still exists to a certain extent, it is gradually being overcome. The people are thrifty and glad to utilize whatever proves to be advantageous and profitable in the end. The progress already made by enterprising American exporters conclusively shows what can be done toward entering their goods. The proper and only way to successfully market our goods in France is to send over a salesman or representative, or to select in France a traveling salesman, who will sell their goods. As I have observed before, it is almost useless to write to retail dealers. The French, as stated before, are reluctant to accept anything that is new, and products must in a certain measure be forced upon them; this can never be attained by writing letters, but only by close, personal work.

Washington, D. C. A. F. Tennille.

Death of E. F. C. Davis, President A. S. M. E.

Less than three months ago we announced the death of Mr. Eckley B. Coxe, late president of the American Society of Mechanical Engineers, and this week we have to record the tragic end of his immediate successor in office, Mr. Edward F. C. Davis, who was killed in Central Park, in this city, while riding horseback for recreation on the evening of August 6th.

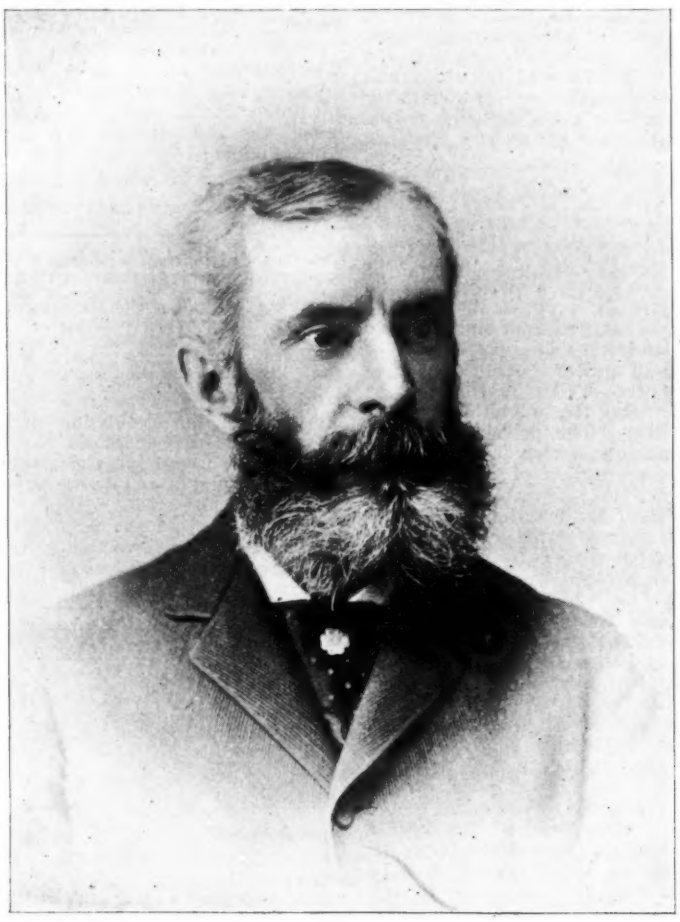
Mr. Davis was born at Chestertown, Md., August 13, 1847, and consequently one week later would have been 48 years old. He was graduated from Washington College, Md., in 1866, then underwent a course of instruction in the drawing room and shops of the Philadelphia Hydraulic Works, of Benton & Henderson; then he was draftsman successively at the New Castle Machine Works, New Castle, Del.; Atlantic Dock Iron Works, Brooklyn; Atkins Bros.' Rolling Mills, Pottsville, Pa., and the Colliery Iron Works, Pottsville, Pa. In March, 1878, Mr. Davis entered the employ of the Philadelphia & Reading Coal and Iron Company as foreman of draftsmen, and in 1881 he had risen to the position of superintendent of the company's shops at Pottsville, where all the machinery for their 56 collieries was built and repaired. Mr. Davis in 1890 became manager of the Richmond Locomotive and Machine Works, occupying that position for four years. At the time of his death he had been superintendent of the extensive works of C. M. Hunt & Co., upon Staten Island, for about four months.

Mr. Davis became a member of the American Society of Mechanical Engineers November 4, 1881. He was an active member, and contributed of his experience in its discussions and of his wisdom in its councils. He was vice-president of the society for two years, 1891-93, and was elected president November, 1894, for the ensuing year. The first vice-president of the society, and now its acting president, is Mr. C. E. Billings, of Hartford, Conn.

It was expected that in his annual address to the society Mr. Davis would have taken as his topic the system of piecework, which he was conducting with great success and all-round satisfaction in the works under his supervision. It must now be presented, as we trust it will be, by some other. The system would seem to have much to commend it. It is a system of actual individual bargains for each job with each man, a mutual business transaction between man and man, like the buying or selling of goods, which is always more or less of a compromise, but which should always result in the mutual satisfaction of the contracting parties. In connection with the system, or as a part of it, a complete record is, of course, kept as a basis of future negotiations. Another peculiarity of the system is in the abolition of pay-days—every job being paid for in spot cash as soon as it is finished. We regret that we cannot at this time speak of the system in fuller detail, but it will be properly presented at a later day.

Mr. Davis left a wife and four children, who were in Richmond at the time of the sad occurrence.

Funeral exercises were held at Pottsville, Pa., where Mr. Davis had many friends among his former associates and employes, and a number of members of the A. M. S. E. were in attendance.



E. F. C. Davis.

The Alleged New Astronomical Instrument.

Some time ago the *Springfield Republican* published an item as follows:

Astronomers have suddenly discovered the force of the story of Mohammed and the mountain. After laborious toil at constructing enormous and complex mechanisms by which great telescopes can be directed to any quarter of the heavens, they have all at once bethought themselves of the plan of leaving the big tube immovable and horizontal, and throwing the image of the desired star into it by means of a reflector. This surprisingly simple plan is to be followed in mounting the great telescope which is to be a feature of the Paris Exhibition in 1900.

We thought we recognized in this alleged discovery a reference to perfectly well-known instruments, and asked our friends, Warner & Swasey, the great telescope makers, to throw some light upon the subject. In reply we have received the following letter:

I have not seen the newspaper article, but presume it refers to the great siderostat which the French Government is building for the Paris Exposition of 1900.

When in Paris last fall I visited Mr. Mantois, the successor to the firm of Feil & Sons in the manufacture of optical glass; the disks of the 40-inch Yerkes object glass having been made by him. Mr. Mantois told me he had agreed to furnish the French Government the crown and flint disks for an objective 48 inches diameter, and that the objective would be mounted in the form of a siderostat, it being considered the best for that great instrument. The Henry Bros., two noted opticians and astronomers of the Paris Observatory, he expected, would grind and figure the lens, but they expressed themselves to me as not caring to undertake such a difficult task at their time of life. There will, however, be plenty of time to change their minds, for Mr. Mantois was sure it would take the two years allowed him, and probably more, to make the disks.

In the siderostat the object glass and eyepiece are mounted permanently, the light being reflected into the object glass by means of a mirror which is moved by clock-work. With this form of mounting the astronomer can make his observations without changing his position, and as the mirror and its mechanism for operating it are the only parts that must be placed outside of the building, and protected from the weather, no dome is required.

The mirror of the siderostat, which is necessarily much larger than the objective, must be perfectly true, and it requires the utmost care to keep its silvered surface in good condition. The mechanism by which it is made to follow the star is very ingenious and somewhat complicated, requiring the very highest order of construction. The mirror for the 48-inch siderostat will be 80 inches diameter, about 10 inches thick, and will weigh in the neighborhood of three tons.

The siderostat being a combined reflecting and refracting instrument has necessarily many of the imperfections of both, therefore, astronomers generally prefer to use either a refractor or a reflector, and in this country they are especially favorable toward the former.

The heliostat is practically the same instrument as the siderostat, one being used for observing the sun, and the other the stars, as the names would indicate. Professor Langley, of the Smithsonian Institution, has the largest heliostat in this country, which he uses in photograping the solar spectrum.

The equatorial coude is another form of mounting which French astronomers have favored. In this instrument there are two mirrors, the light being reflected twice after passing through the objective. There is considerable loss of light due to the two reflections, which the astronomers are willing to sacrifice in order that they may gain the advantage of carrying on their observations from a fixed position. In this form of mounting it has been very difficult to keep the mirrors in good condition, and especially in the large instrument that was completed for the Paris Observatory two or three years ago. The mirrors are very sensitive to slight changes in temperature, and as one of the astronomers remarked to me, "they have to be cared for as tenderly as an infant." Unless these objections can be overcome, it can hardly be expected that another large equatorial coude will be constructed. It is well that the French Government are going on with the work as proposed, for it will give astronomers a chance to thoroughly test the siderostat having the largest objective that has yet been undertaken.

As to the mounting of these large instruments, it matters not whether the astronomer prefers to have the light from the stars refracted, reflected, or both, for in either case there are many difficult problems to be solved, and in order to keep pace with the very perfect optical work which is now produced, the construction of the operating mechanism must be in every respect the very best.

Hoping that I have been able to reflect some light upon your questions, I am,

Yours very truly,

Ambrose Swasey.

P. S.—As the astronomical correspondent of our firm (Mr. Warner) is now on Cape Cod enjoying the ocean breezes, I have answered your questions as best I could with my limited knowledge of heavenly matters. A. S.

No Prize for Flying Machine.

Some time ago, in reply to a question, we said that so far as we knew there was no standing reward offered for a successful flying machine. Thereupon we were furnished with a newspaper article describing a new flying machine, the inventor of which stated that he was going to try for the prize of $100,000 "offered by the Interstate Commerce Commission, to be paid to any inventor, in any part of the world, who may before the year 1900 turn out a ship that will in a practical manner navigate the air, carrying freight and passengers at a speed of thirty miles per hour."

We considered it absurd that any one should really think that the Interstate Commerce Commission had made any such offer, but in order to be able to authoritatively deny it, wrote to the secretary of the commission, and have received the following reply:

Dear Sir—Your letter of the 30th ultimo is the first information in relation to the matter referred to which has come to the knowledge of the commission.

Very respectfully,

Edw. A. Moseley, Secretary.

Cheap Material in Car Wheels.

A manufacturer of car wheels states in *The Street Railway Journal* that he is obliged to use the cheapest kind of scrap because the managers of some electric roads refuse to pay for good iron. If this is the case we may expect to hear of more accidents like that in New Bedford, where thirty passengers were injured by the breaking of a wheel which, when examined, was found to be granular, and not firm and clear. There is no economy in buying wheels made of poor material. One accident may cost enough to equip the entire system with reliable wheels. The wise railway managers will not tempt

juries to award heavy damages by refusing to allow the wheel manufacturer a fair profit on an honest article.—*Providence Journal.*

The same principles apply to a good many other things besides car wheels—boilers for one notable instance. One trouble seems to be that there are too many buyers who will take the word of an agent for the quality of the thing they are buying. If it is claimed and strongly enough insisted upon by the seller that his article is as good as so-and-so's though much lower in price, it is too often accepted without being submitted to any test whatever except in use, where a failure may cause the death of a number of persons, who have a right to suppose that intelligent and trained men of experience have selected the material, upon the integrity of which so much depends. Instead of which it too often happens that a purchasing agent or other entirely unfit person selects the material and it is accepted and put in use absolutely without any pretense of preliminary testing such as should be done with all material which is to be a component part of any structure upon which life depends. There is far too little testing of materials by competent and disinterested engineers, and it would be to the interest of the better class of managers and owners of railroads, as well as the public, if laws could be passed and enforced which would insure that at least reasonable precautions were taken to secure honest and reliable material.

The Draw Cut.

The following item has started on its rounds in the "mechanical" and "scientific" periodicals, and we are able already to quote it at second or third hand:

"This matter of varying the angle of cut by varying the motion of the cutting tool is something that is learned almost instinctively in actual practice. The small boy very quickly comes to understand that his knife will cut better if he gives the blade a drawing motion while cutting. This is due to two reasons: One that the knife, on the rare occasions when it is sharp, is microscopically a saw, and the drawing motion gives the teeth a chance to act; and the other that, as the drawing becomes more rapid, the cutting angle of the blade is made smaller and sharper, so that a rapid draw really gives a temporary sharpness to the instrument."

This touches upon a topic of vital importance to every one who has to do with the making of chips, and it strikes us as somewhat unfortunate both in what it says and in what it omits to say, and if allowed to go unchallenged, or without further explanation or illustration, it might be more misleading than instructive.

In venturing upon a little consideration of the operation of a cutting tool, as referred to above, we will continue the assumption that the work or material is stationary, and that all the motion is in the knife or cutting tool. In the first place, there is no such thing as a "draw" cut in the sense in which the word is frequently used in this connection. The allusion to the saw teeth above, and the assumption of their assistance in the act of cutting, assumes that the cutting edge moves longitudinally, so that the teeth can perform their function, while the wedge-like action of the knife also goes on by the advance of the cutting edge. There is no such double movement of a cutting edge, or of anything else. Nothing can ever move in two directions at the same instant. The direction of motion may be constantly changing under the operation of two or more forces, but the resultant force is always single, and the motion is also at any instant single in direction. When the thin or "sharp" edge of the knife advances into the material, its action is that of a wedge entirely. As soon as contact occurs between any portion of the cutting edge and the material to be cut any subsequent advance of the cutting edge into the material is the advance of a wedge, or the sundering of the material by the successive occupation of any point situated between the chip and the stock by a thicker portion of the blade than the portion of it which has previously occupied the place. This is true whether the line of advance be at a right angle to the cutting edge or at any angle more acute. Thus, with the knife edge *a b*, Fig. 1, cutting the material *c*, there may be a force at the back of the blade acting in the direction of the arrow *d* and another force pulling the blade in the direction of the arrow *e*, in which case the direction in which the blade actually moves relatively to the material may be that of the arrow *f*, and this is what is popularly known as the "draw" cut. It is difficult to see how any microscopic saw teeth that might exist upon the edge of the blade could have the slightest sawing action. In Fig. 2, the machine knife has its cutting edge *a b* at the same angle to the line of motion *c* as that of the hand knife to its

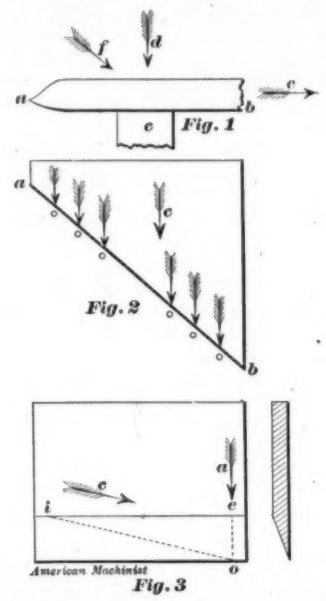


Fig. 3

actual line of motion in Fig. 1. As this cutting edge in Fig. 2 advances in the direction indicated by the arrow *c*, coming in contact with the material at certain points, as *o o o*, there is not the slightest longitudinal movement of the cutting edge, but simply the straight advance of the knife into the material in the direction of the several arrows.

It is obvious that the speed at which the knife might move would not alone have anything to do with changing the cutting angle of the blade or giving it a "temporary sharpness." The speed of the cutter is an important factor in all cutting operations, and in many cases power and time are both saved by higher speeds and thinner cuts, the resistance of the chip in being severed, or the power required to roll it away, varying greatly with the thickness of it.

While we do not accept the explanation of the draw cut, which assumes that it does anything resembling the action of a saw, we are not denying its value and importance in cutting operations. The advantage of the draw cut is so evident in practice, and its use is so universal, that no further evidence of its efficiency could be required, but it is not necessary to assume in explanation that any of its success is due to the action of microscopic or infinitesimal teeth. If the knife be regarded as a wedge pure and simple, its action is clearly and satisfactorily explicable upon that assumption alone. The sharper and keener the edge the better it will cut as a knife, and the sharper and keener the edge the fewer will be the irregularities and imperfections that by a mistaken hypothesis are called saw teeth or file teeth.

Say that we have a knife blade ½ inch thick, and flat upon one side, while the cutting edge is formed by beveling the other side, the bevel extending back ½ inch from the cutting edge. If this cutting edge were formed by beveling both sides of the blade back the same distance, the resulting angle would be practically the same, and the cutting edge would then, of course, be in the middle of the blade. The first style of forming the cutting edge is rather the simplest to follow in use, the motion of the knife being always in a plane parallel to the flat side of the blade, and nothing being said about clearance. Now, if the knife advanced into the material in the direction of the arrow *e*, or at right angles to the cutting edge, it is evident that when it had gone ½ inch the blade would have entered into the material, or between the chip and the stock, up to its full thickness, and the section of the wedge involved in the operation would be the normal section of it, or would be the full angle formed by a base of ½ inch, a perpendicular of ½ inch, and the hypothenuse returning to the apex of the angle. But if, instead of moving in the direction of the arrow *a*, the blade advanced into the material in the direction of the arrow *c*, so that, with the contact between the blade and the material commencing at a certain point *o*, the path of the blade into the material would be along the dotted line *o i*, the distance from *o* to *i*, or from the edge to the full thickness of the blade, being 2 inches, instead of, as in the first instance, ½ inch, it is evident that the section of the wedge entering the material along the line *o i* would be much more acute than the section of the same wedge along the line *o e*. This is not giving the blade a "temporary" or apparent sharpness, but an actual sharpness, and, besides that, it looks also like giving it a more permanent sharpness, for the simple reason that a proportionately increased length of cutting edge is employed for the same cut.

We put this matter in this shape not with the hope of settling anything, but rather of suggesting or provoking some further thought and investigation along this line. The draw cut is especially commended to the consideration of workers in metal, and we have an impression that they have not heretofore looked into it as they should. While acute angles are not usually permissible for the cutting edges for operating upon metal, on account of the weakness of such edges, and also on account of the impossibility of keeping them cool enough for their own safety, it will be seen that any cutting angles that are less than a right angle can by the use of the draw cut be rendered practically much more acute in their operation, and it would seem that such cutting edges should be also more lasting.

Fast Locomotive for the C., B. & Q. Railroad.

The Baldwin Locomotive Works, Philadelphia, Pa., have now in the course of construction a locomotive intended for the fast mail trains on the Chicago, Burlington & Quincy Railroad. This engine will have two pair of driving wheels, diameter of drivers 84 inches; a leading and a trailing truck with wheels 50 inches diameter; cylinders, 19 inches diameter, 26 inches stroke; steam pressure, 200 pounds per square inch; total weight of engine about 125,000 pounds. This engine is expected to make 80 miles per hour.

The engines at present in use make exceptionally good time, but the new engine is designed to be better adapted to the service. It is said that if this engine proves to be satisfactory an order for a number of engines of the same class will be given to the Baldwin Works.

Baldwin and Westinghouse Co-operation.

Announcement is made that the Baldwin Locomotive Works, of Philadelphia, owned by Burnham, Williams & Company, and the Westinghouse Electric and Manufacturing Company have been to some extent amalgamated. The details of the arrangement are not at this writing made public. The Westinghouse Company is incorporated, while the Baldwin Works are not. It is understood that there will be no changes in the two plants except by additions to each according to business developments. For the profitable production of the electric locomotive in the numbers, and with the rapidity which the near future will probably demand, such an alliance or combination would seem to be quite natural and almost inevitable. Neither company alone could have been expected to turn out a complete electric railway plant as well as it can be done by the two working together.

It is understood that the two companies are not combined, but that they will merely co-operate in the production of electric locomotives.

Atlantic Coastwise Canal.

We have received a printed copy of the "Report of the Canal Commission of Philadelphia." This is a commission appointed for the purpose of investigating and reporting upon the feasibility of constructing a ship canal which, if built, would connect the ports of Philadelphia and New York by an inland water-way that would, of course, prove very advantageous to commerce, and would probably be of very great value should it ever be necessary to protect the Atlantic coast from a foreign enemy. The report sets forth the entire engineering practicability of the undertaking, showing not only that it would be possible but easy to construct such a canal along the proposed route, and that it would save about 11 hours time on an average for boats that now have to pass along what is probably the most exposed and dangerous part of the coast. The cost of construction, with 20 feet depth, is placed at $14,574,100, and with 28 feet depth at $24,124,700.

Back Numbers of the American Machinist.

We feel it to be our duty to warn our friends of a possible difficulty in getting back numbers of the American Machinist. A great many letters addressed to this office are inquiries about, requests or orders for, certain back numbers or certain articles, or series of articles, published in previous years. As has been heretofore announced, we cannot now supply copies of the American Machinist published previous to January 1, 1894, except as parts of complete volumes, and the supply of these volumes is limited—in fact exhausted for the years previous to 1880, and for the years 1881, 1883, 1884 and 1885.

The files of the American Machinist contain a very valuable record of machine shop practice and mechanical engineering, and are becoming constantly more and more valuable. It is impracticable, however, for this office to continue to furnish back numbers, and it is not the intention to furnish them hereafter, except for the year previous to current publication. We have many requests for back numbers to complete files—numbers which we cannot supply. It is a well recognized fact that it pays to have files of the American Machinist at hand, if one has much to do with the machine business, but our friends must see to it that they have all the numbers as they go along.

The recently rendered report of the Commissioner of Patents shows that 20,745 patents were granted in 1894, and that receipts of the office for the year exceeded expenditures by $157,390, the latter being $1,195,557.

In the last week of June this year all but one of the thirty-four divisions of the Patent Office had their work up to within thirty days of date.

If better or additional evidence of continued improvement in business were needed it could be found in the report of railway earnings for the month of July, which on many of the most important systems show a very great increase over the corresponding month last year.

Operating expenses are also somewhat increased, showing that the roads are spending more money for maintenance, and it seems certain that it cannot be much longer before most of them will be purchasing and employing labor on the scale of 1892.

Iver Johnson, of Fitchburg, Mass., head of the firm of Iver Johnson & Co., manufacturers of the Lovell "Diamond" bicycle and firearms, died the evening of the 3d inst. He was born in Nordfjord, Norway, in 1841, and after serving an apprenticeship to a gunmaker in Bergen, came to this country, and, settling in Worcester in 1871, began the manufacture of pistols, to which he subsequently added drop forgings, breech-loading rifles, bicycles, etc. He transferred his business to Fitchburg a few years ago.

Machinery Wanted in India.

Mr. L. K. Kirloskar, Victoria Jubilee Technical Institute Staff, Parel, Bombay, India, writes and requests us to ask manufacturers of machines for making wicks for kerosene lamps; machines for making matches and match boxes, and machines for manufacturing small steam engines and boilers, to send to him their catalogs. Manufacturers of such machinery may consider this an invitation to send catalogs.

The Oldest Engine in America.

In our issue of September 22, 1892 we illustrated and described a beam engine, then running in Savannah, Ga., that was built by Boulton & Watt, and had been recently repaired by John Rourke & Son., who now inform us that the mill in which the engine was running burned recently, but that the engine was only slightly damaged. They have purchased it, and intend to send it to the Atlanta Exposition. They believe it to be the oldest engine in America.

The Great Wheel at Earl's Court had to be stopped some time ago for alterations, as with the radial spokes employed the wheel was not stiff enough for the speed of revolution desired. A number of tangent spokes were accordingly added, and a fresh start was made on Wednesday afternoon. The arrangements for driving, however, broke down, and the passengers were kept prisoners within the cars of the wheel for several hours.—*Engineering* (London).

Imagine the abuse that would have been heaped upon American engineering and Americans generally by certain English journals had the Ferris wheel at Chicago played any such tricks.

Since writing the above we have seen an extract from the London *Saturday Review*, in which this unpleasant experience of English pleasure seekers is attributed entirely to Americans for inventing such forms of amusements, and we are assured that "the soullessness of these American amusements is appalling," and that they "testify to a depth of vulgar stupidity that would have astonished the builders of the Tower of Babel."

There is at present such a superabundance of molasses in Louisiana that means must be devised for getting rid of it, and it is thought that with a suitable furnace it could be burned. It is said to be almost pure carbon, but that no practical way has yet been discovered of introducing it to the furnace. We should think some of the compressed air or steam jet spraying nozzles or burners that are used with oil could easily be modified so as to adapt them to handling molasses, if that is all that is required.

It is claimed that a new Pennsylvania engine, "No. 92," recently drew a train from London Park to the Washington Navy Yard 35½ miles in 33½ minutes, and that part of the distance was covered at the rate of 102 miles per hour.

NEW CATALOGS.

There are three sizes of Standard Catalogs, 9" × 12", 6" × 9" and 4½" × 6". We recommend the 6" × 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

We have received from D. Van Nostrand Co., 23-27 Warren street, New York, a small catalog of the Van Nostrand Science Series, which series is well known to those who are interested in technical literature. The catalog gives names of the latest additions to the series, and is sent to any address on application.

We have received from Gould & Eberhardt, Newark, N. J., a catalog illustrating and describing their improved gear and rack-cutting machinery, containing useful information and valuable tables and rules pertaining to the subject of gear cutting. It will be found of interest to mechanics who have to do with such matters, and is sent to any address on application. It is 4¾"x7¼".

We have received from the Clayton Air Compressor Works, Havemeyer Building, New York, a catalog devoted to the illustration and description of the various forms of Clayton air compressors, and description of typical plants in which compressed air is used for various purposes. There are also a number of testimonials from those who have used Clayton machinery. It is 8"x10⅞".

The Morse Machine Co., Rochester, N. Y., send us a catalog of drafting-room furniture, in which are illustrations and descriptions of various forms of improved drawing tables, drawing boards, cabinets for drawings, drawing paper and drawing boards, blue-print frames, easels, reference book cabinets, desks, specially adapted for drafting-room use, and filing cabinets of various kinds. This catalog is 5⅛"x8⅝". It is sent to any address on application.

MANUFACTURES

The Maryland Steel Co., of Baltimore, Md., will increase wages 10 per cent.

The Vulcanized Pulp Co., of Kansas City, Mo., will shortly erect a pulp mill.

A pulp-mill will shortly be erected at Bristol, Tenn. Geo. R. Sherman is interested.

C. H. Thompson and others, of Salisbury, N. C., are organizing a company to build a $60,000 spinning-mill.

The Alpena (Mich.) Woolen Mills has been incorporated recently by O. L. Partridge and L. V. Smillings.

The New Process Mfg. Co. has been organized at Dallas, Texas, with $50,000 capital, by C. E. Hooper and others.

The United States Nut Lock Co., of Pittsburg, Pa., has been organized by Robt. C. MacChesney and others.

The Springfield (Ill.) Mining Co. has been organized by E. L. Link and J. W. Hogg, with a capital of $25,000.

Wm. C. Allison and others will rebuild the paper-mill at Mt. Holly, Pa., which was recently destroyed by fire.

Aaron French and others have formed a company to build a sewer pipe and drain tile factory at Elmendorf, Texas, to cost $100,000.

A new company has been formed to build a cotton-mill at Lumberton, N. C. The officers are S. Godwin, president; N. A. McLean, vice-president, and A. McAllister, secretary.

The Brooks Locomotive Works, Dunkirk, N. Y., York (Pa.) Rolling Mills, and the National Water Tube Boiler Company, of New Brunswick, N. J., are amongst the establishments that have recently advanced wages.

Machinists' Supplies and Iron.

New York, August 10, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.75 for No. 2 Plain, and $12.50 for Gray Forge. Southern brands, $13.50 to $14 for No. 1; $13 to $13.25 for No. 2; $12.50 to $12.75 for No. 3; $13 to $13.25 for No. 1 soft; $12.75 to $13 for No. 2 soft; and Foundry No. 4, $12.25 to $12.50

Antimony—The market is moderately active and prices are barely steady. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8½c; Hallett's, 7.15c. to 7.30c.; U. S. French Star, 7.35c.; Japanese, 6.85c. to 7c.

Lard Oil—Prime City we quote at 51c. to 52c.

Copper—Business has been somewhat checked by another advance in prices. Lake Copper is quoted at 12c. Second hands have made a slight discount and accepted 11⅞c. net cash. Casting Copper is held at 11c. to 11¼c.

Lead—The tendency of the market is towards advanced prices, which is met by a decided resistance, and has effected business. For round lots 3.55c. has been paid, and single carloads were sold at 3.60c.

Spelter—The market is firm and more active. Business has been done at 3.90c. to 3.95c., and at present 4c. is asked for New York delivery.

Tin—Prices have fallen; 14.20c. is now quoted, and somewhat lower figures have been accepted.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Bright, active machinists to canvass for subscription to American Machinist, liberal commission. Address, with refs., Subscription Dep't, American Machinist, 203 Broadway, N. Y.

A good machinist, 15 yrs. exp., desires a permanent pos.; best of refs. Box 84, Am. Machinist.

(*Continued on Page* 653.)

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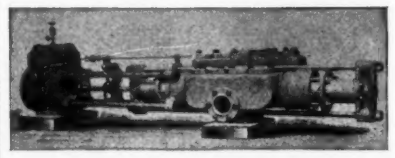

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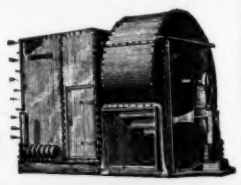

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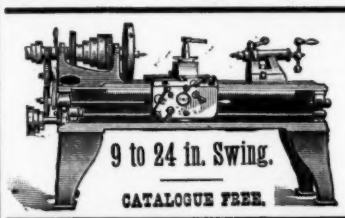

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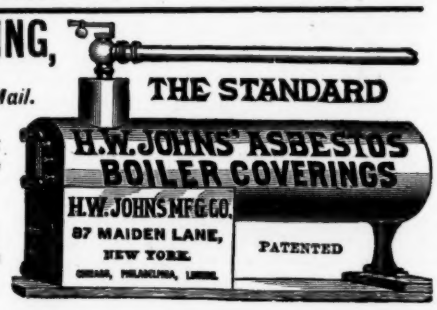

First-class patternmaker, American, wants position, competent to take charge. Address Box 74, AMERICAN MACHINIST.

Patternmaker wanted. Engines, gearing, etc. State experience and pay for permanent work. Address New Hampshire, care AM. MACHINIST.

Wanted—Situation as general foreman or superintendent of high speed engine shop; at present supt. of shop. "D. A.," care AM. MACHINIST.

Practical machine man with some money to take charge of foundry and machine works. Address D., care AMERICAN MACHINIST.

Mechanical draftsman with technical education, shop and office experience, wants position. Address Box 68, AMERICAN MACHINIST.

Mechanical engineer, technical graduate, and experienced draftsman, would like pos. as assistant superintendent or draftsman. Box 81, AM. MACH.

Young draftsman with 2½ years' experience in drafting room and 1½ years in machine shop wants position. Address T. H. S., AMERICAN MACHINIST.

Mech. supt. of general foundry, machine and boiler works, power transmission, factory construction, steam heating, modern methods; ample refs., wants pos. Mechanical Supt., AM. MACH.

Experienced Designer Wanted—Familiar with all classes of bookbinders' and paper-cutting machinery, for the West. Address, stating all particulars, "A," care of AMERICAN MACHINIST.

First-class millwright, good draftsman, foreman in leading millwright and machine shop, wishes to make a change; A1 references. Address Mill, 177 E. 73d Street.

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Wanted—A working foreman for pattern shop doing general machine work in Western Illinois; state age, experience and wages expected. Box 80, AMERICAN MACHINIST.

Wanted—Foremanship of machine shop, eight years' experience as foreman. Able, energetic. Age, thirty-three. Good references. New York State preferred. Address Box 82, care AM. MACH.

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Wanted—An instructor in the mechanical engineering department at University of Illinois, to teach elements of machine design. Address, with references, L. P. Breckenridge, Urbana, Ill.

Wanted—A bright, active, experienced man for erecting and testing high-speed engines, with ability to fill position of working foreman in erecting shop if desired; write previous experience, age, and wages wanted. N. J., AM. MACHINIST.

Wanted—Position in drafting room or shop by man of long experience in designing and building special machines, tools and fixtures; has had charge of shop. Box 79, AMERICAN MACHINIST.

First-class die and tool maker, well posted on sheet-metal work and tinware; must be capable of laying out work and assisting in new work. Metal Manufacturer, care of AMERICAN MACHINIST, New York City.

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Position wanted as foreman master mechanic, or any capacity requiring the services of a first-class mechanic; experienced in marine and stationary engine building and rolling-mill work, and very good draftsman. Box 64, AMERICAN MACHINIST.

Wanted—A practical man with some capital, a knowledge of drawing and mining machinery, to take charge of a foundry and machine shop in a mining district. Address, giving references and experience to Box 70, AMERICAN MACHINIST.

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A man aged 29, 14 years' experience as machinist, draftsman and designer with leading firms, wants position in charge of office, or as mechanical superintendent of factory; write for references. Box 71, AMERICAN MACHINIST.

Wanted—Position as foreman or superintendent, used to designing tools for close interchangeable work to reduce cost; have had charge of light and heavy work; had experience building dynamos. Address A. T., AMERICAN MACHINIST.

Wanted—By steady, sober, experienced machine and jobbing molder, position where molder is required to understand melting and the management of small shop in city or country. Address F. C. N., AMERICAN MACHINIST.

Wanted—Any firm wanting an engineer who can establish discipline and systematic methods producing lowest cost and best workmanship, as superintendent or manager can find a man with highest references and a record by addressing Experience, care AMERICAN MACHINIST.

Wanted—Foundry foreman in a good Western city; must be accustomed to light work; acquainted with the latest and best foundry methods, also understand mixing and melting brass, and a man of good executive ability. Good steady job, state nationality, age and experience; give reference, and state salary expected. Address "Q.," AMERICAN MACHINIST.

Wanted—Foreman for a machine shop manufacturing steam-hoisting engines, and a general line of machinery for coal mines. Must be a good mechanic, and acquainted with the best method of producing first-class work at low cost, and have good executive ability and push; if these requirements cannot be filled, please do not apply. State age, experience, and salary expected; give references. Address "Competent," care AMERICAN MACHINIST.

Wanted—A young man to take charge of our engine department; must have a thorough knowledge of automatic high-speed engines, competent to execute high-grade work and handle 75 to 100 men, so as to turn out work at lowest cost of production; best of tools and equipments furnished; excellent opportunity for a live, active young man; state fully, age, experience, references and salary wanted. Address Buffalo Forge Co., Buffalo, N. Y.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

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Pat's obt'd; no atty's fee until allowed: exp't service. Thurman & Silvius, mech. engs., Ind'polis, Ind.

For sale—Nine volumes AM. MACHINIST, '86–'94 inclusive, cheap. O. H., Rudolph, Nashville, Tenn.

Wanted—Complete volumes for the years 1881, 1883, 1884, 1885, bound or unbound. Address, stating price, AMERICAN MACHINIST.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For sale—Hydraulic press, 14 inches ram, made by John Robertson & Co., Brooklyn, has rapid motion attachment; is in first-class condition. For terms address Press, Box 826, Providence, R. I.

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(*Continued on Page* 654.)

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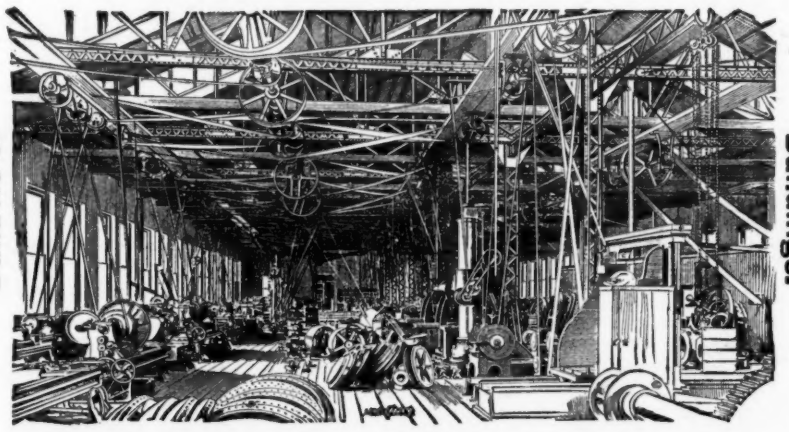

Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the interior of a Machine Shop, the Roof of which was designed and built by us for the Titusville Iron Co., at Titusville, Penn. The building is 70 feet in width by 205 feet in length. The roof trusses are made entirely of iron, and designed to carry shafting. Through the center of the building is a row of wrought iron columns. Machine shop roofs built after this plan are not only much neater in appearance than heavy, cumbersome, wooden trusses, but are stronger and stiffer; and where no wood is used about the construction the danger from fire is entirely eliminated.

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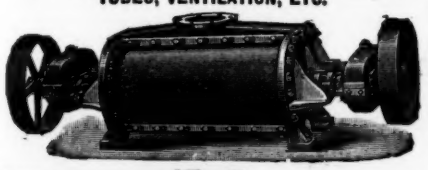

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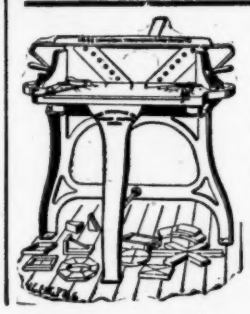

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Universal Trimmer
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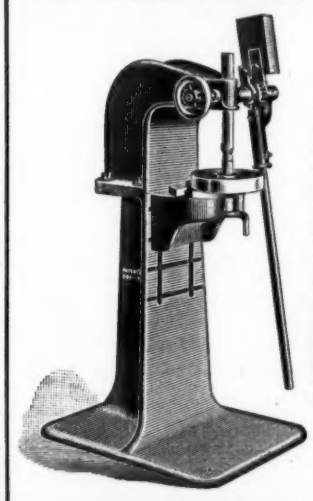

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9	1 3-8	.95
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12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
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Full set of 19		$23.60
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This Dog has a Very Heavy Bore, so that if the thread wears a Heavier Screw can be substituted.

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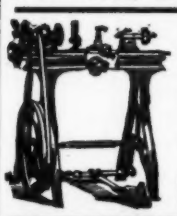

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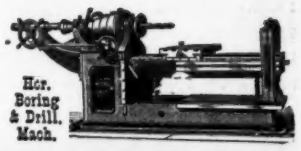

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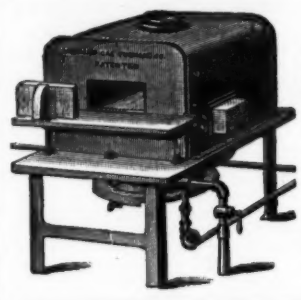

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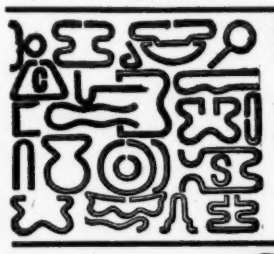

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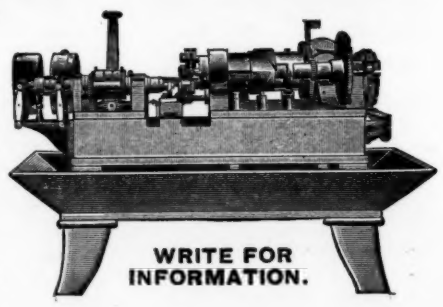

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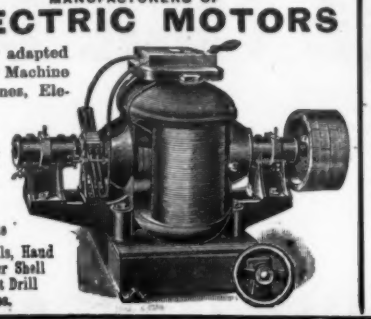

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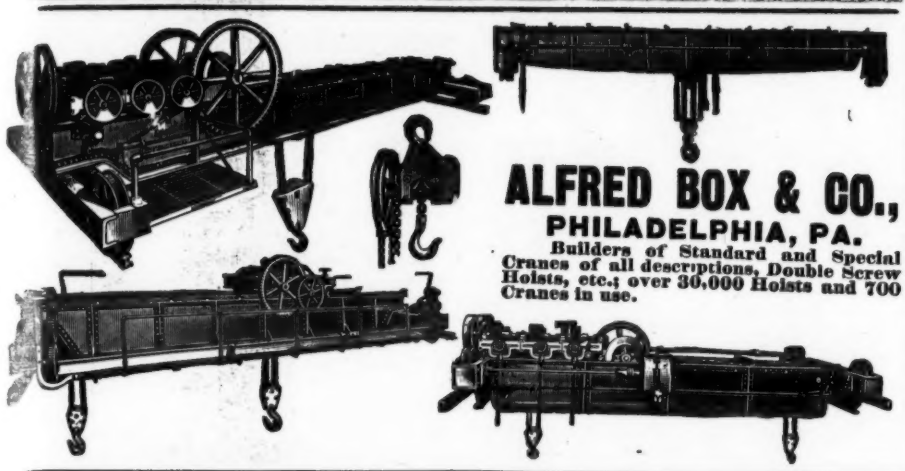

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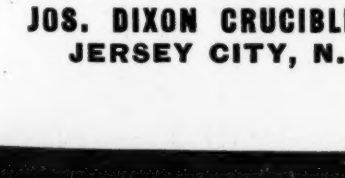

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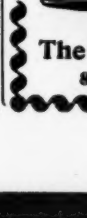

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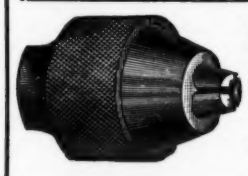

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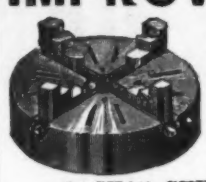

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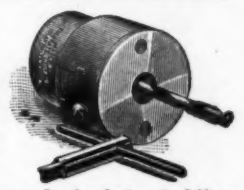

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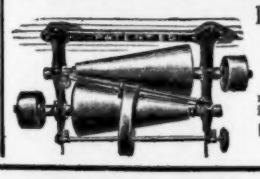

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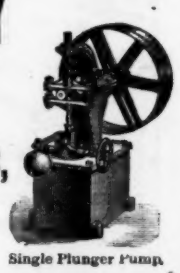

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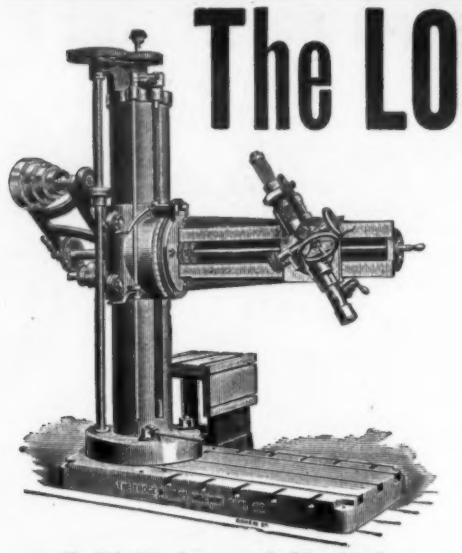

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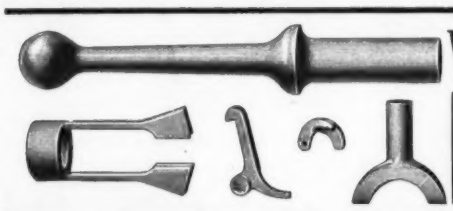

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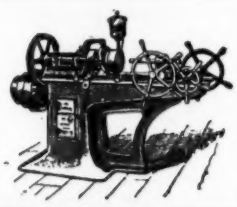

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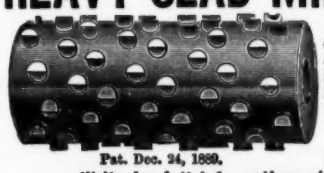

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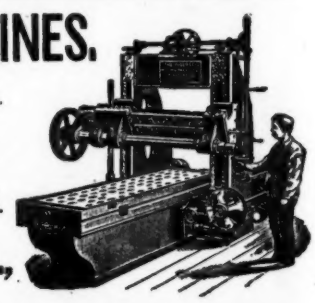

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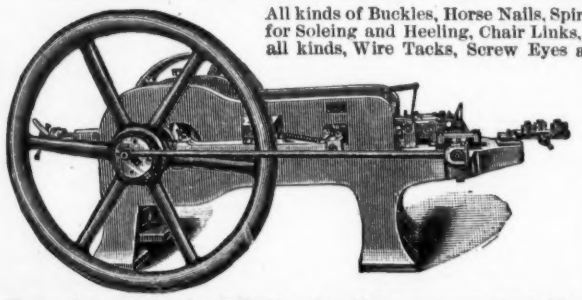

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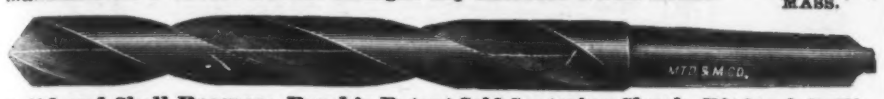

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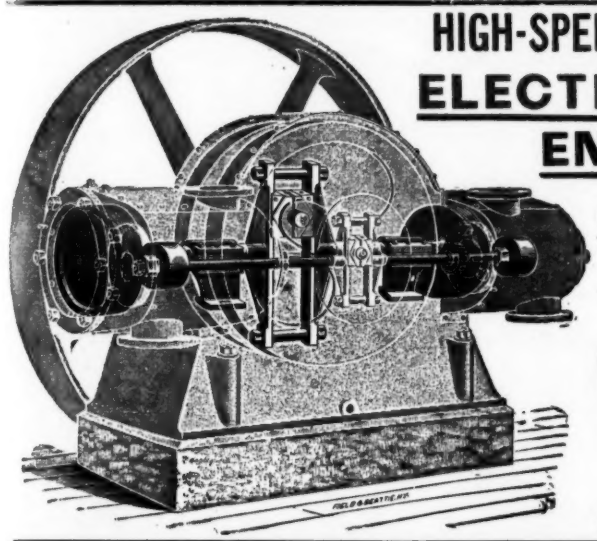

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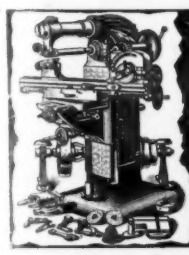

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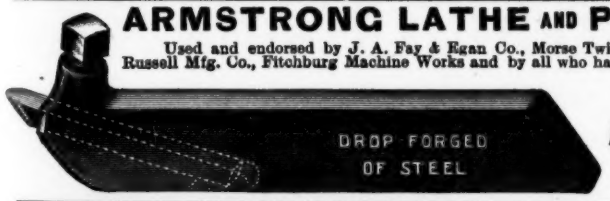

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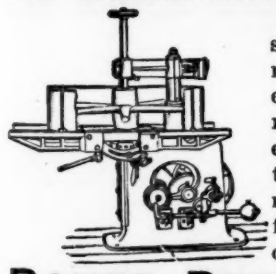

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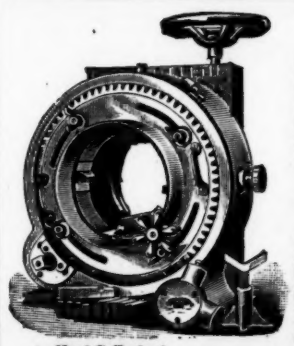

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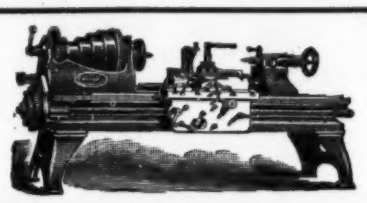

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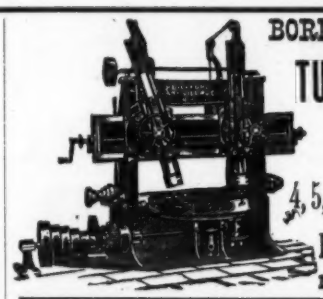

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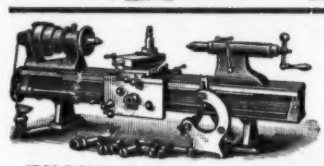

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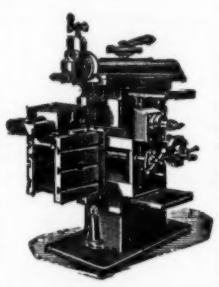

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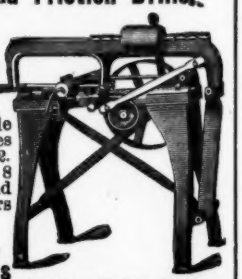

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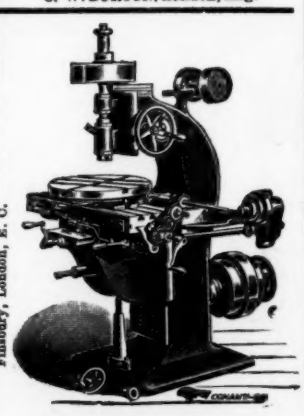

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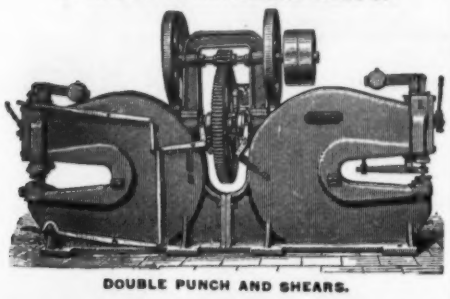

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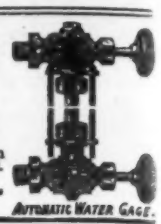

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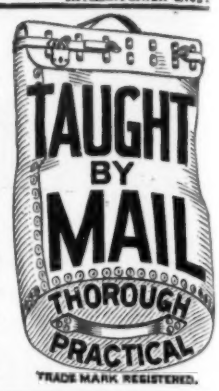

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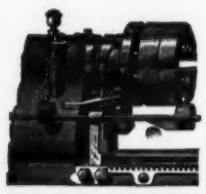

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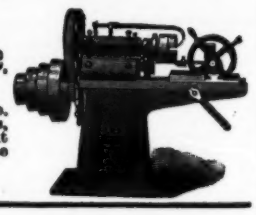

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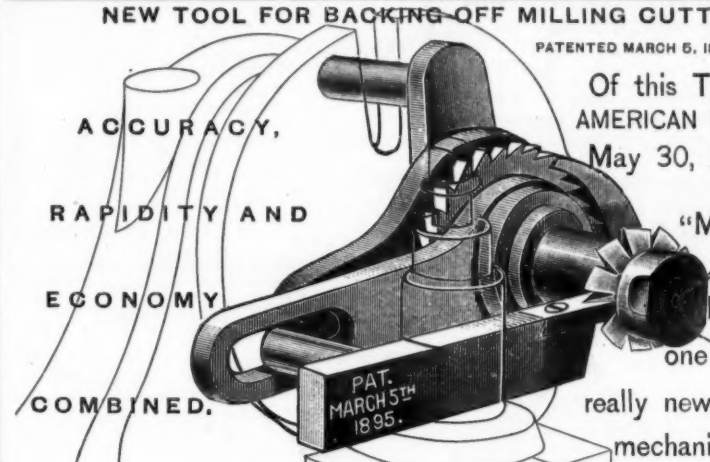

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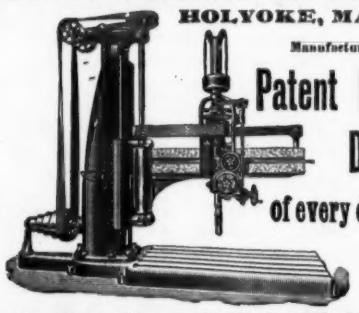

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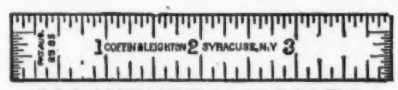

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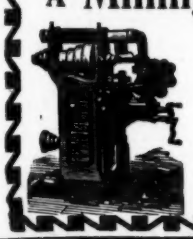

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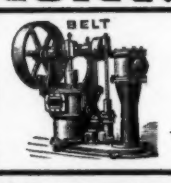

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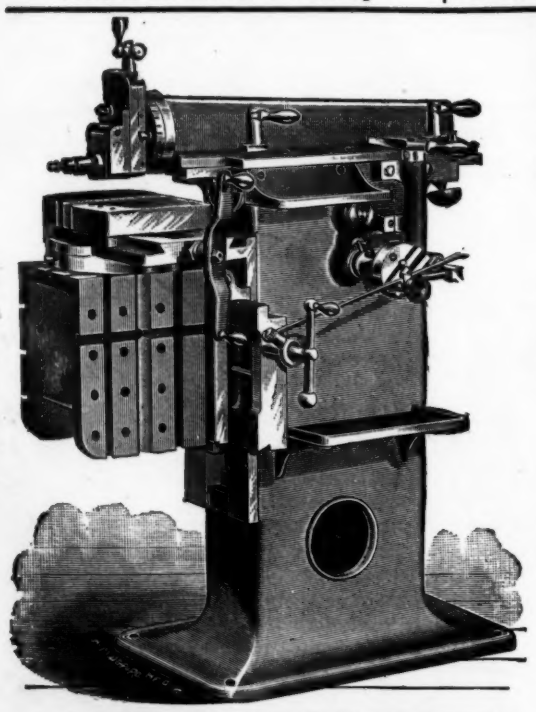

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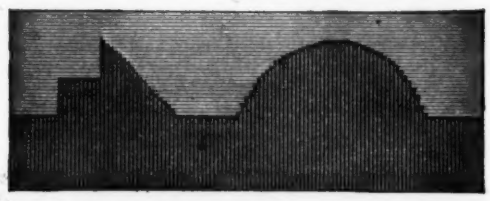

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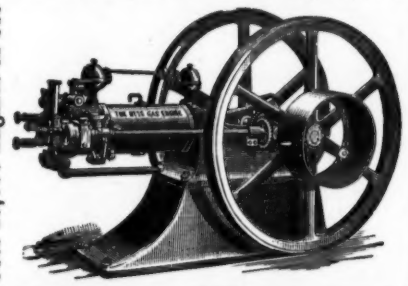

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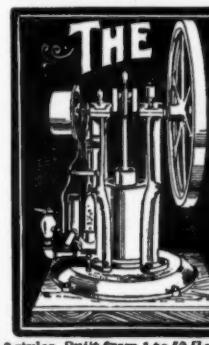

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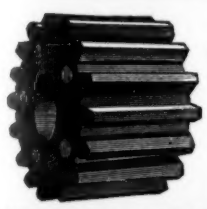

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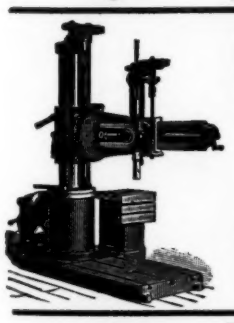

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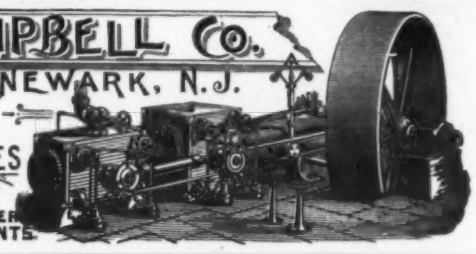

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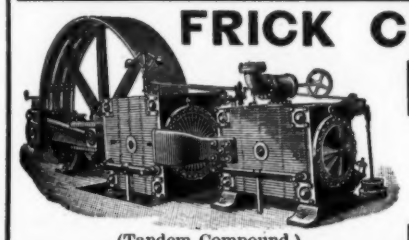

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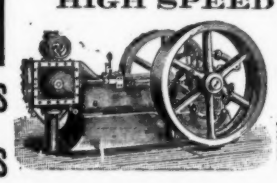

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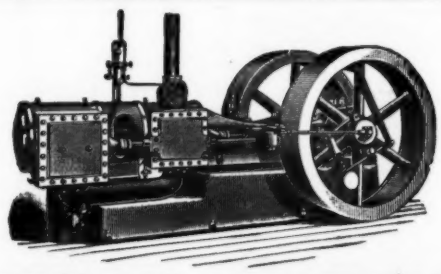

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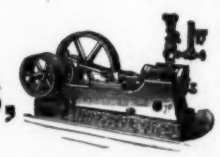

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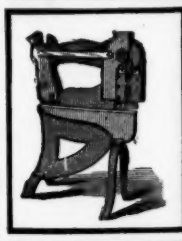

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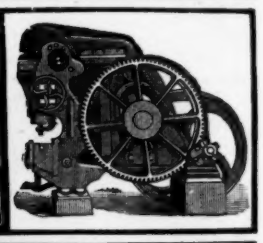

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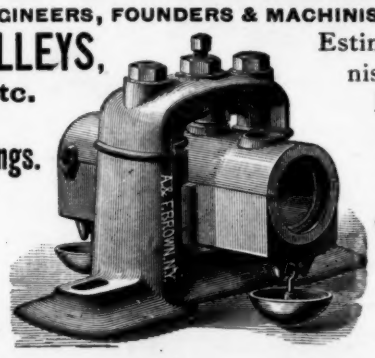

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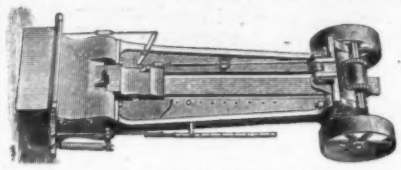

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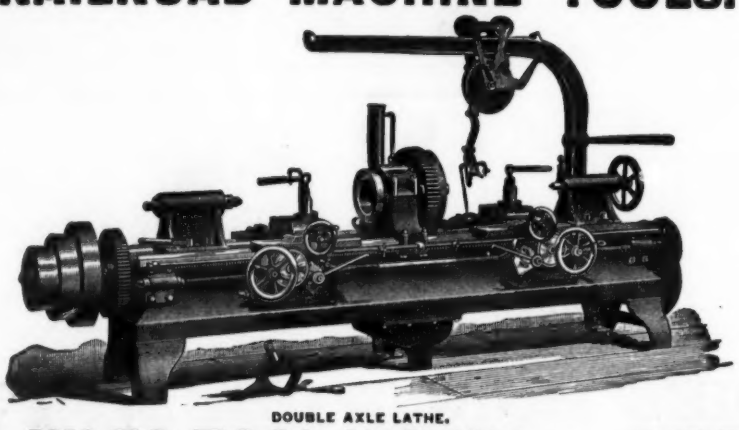

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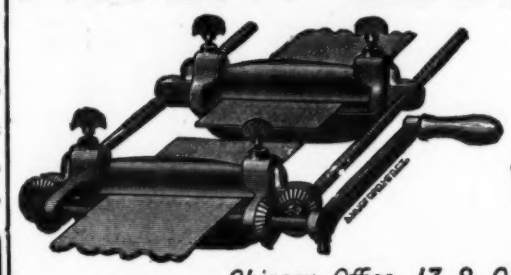

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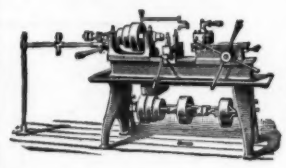

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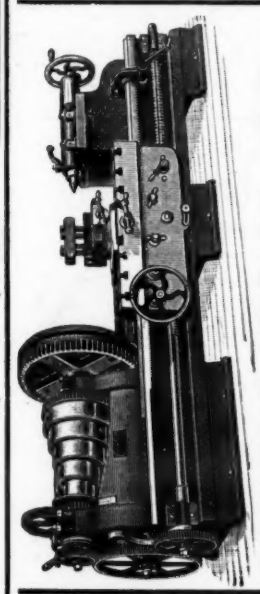

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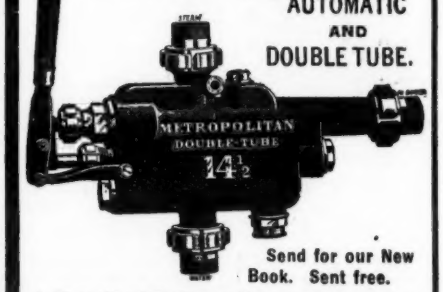

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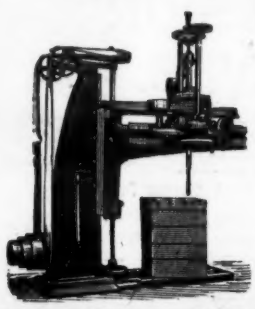

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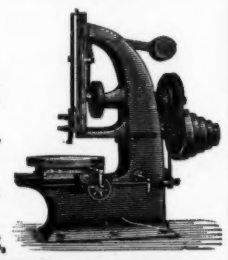

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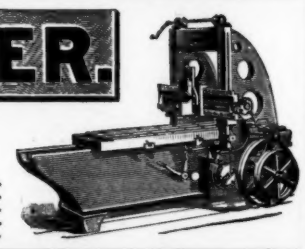

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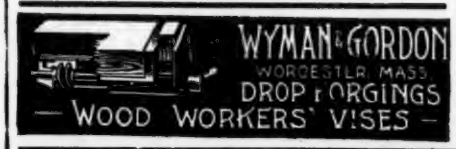

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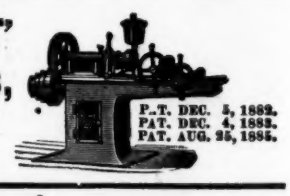

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